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Economic Impact of Implementing Volatile Organic Compound Group II Regulations in Ohio

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Park Ridge, IL

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16. ABSTRACT

The major objective of the contract effort was to determine the direct economic impact of implementing Reasonably Available Control Technology (RACT) standards in Ohio. The study is to be used primarily to assist EPA and Ohio decisions on achieving the volatile organic compound (VOC) emission limitations of the RACT standards.

The economic impact was assessed for the following eight RACT industrial categories: petroleum refinery fugitive emissions; surface coating of miscellaneous metal parts and products; gasoline tank trucks; synthesized pharmaceutical manufacturing; rubber tire manufacture; graphic arts; petroleum liquid storage in external floating roof tanks; and dry cleaners using perchloroethylene.

The scope of this project was to determine the costs and direct impact of control to achieve RACT limitations for these eight VOC industrial categories in Ohio. Direct economic costs and benefits from the implementation of Ract limitations were identified and quantified. While secondary impacts (social, energy, employment, etc.) are addressed, they were not a major emphasis in the study.

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DECEMBER 1981

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The major objective of the contract effort was to determine the direct economic impact of implementing Reasonably Available Control Technology (RACT) standards in Ohio. The study is to be used primarily to assist EPA and Ohio decisions on achieving the volatile organic compound (VOC) emission limitations of the RACT standards.

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EXECUTIVE SUMMARY

Provisions of the Clean Air Act enacted in 1977 require states to revise their State Implementation Plans (SIPs) for all areas that have not attained the National Ambient Air Quality Standards (NAAQS). For areas not attaining the ozone NAAQS, the EPA requires that, at a minimum, an approvable ozone SIP revision must include legally enforceable regulations that reflect the application of Reasonably Available Control Technology (RACT) to those volatile organic compounds (VOC) sources for which EPA has published a Control Technology Guideline (CTG) by January 1978. Also, the SIP should include provisions for the adoption and submittal of additional legally enforceable RACT regulations on an annual basis beginning in January 1980 for sources covered by CTGs that have been published by January of the preceding year. RACT regulations for those source categories for which CTGs were issued by January 1978 (RACT I categories) have already been submitted and adopted by most of the states in their 1979 SIP revisions. The adoption and submittal of additional RACT regulations for source categories for which CTGs were issued between January 1978 and January 1979 (usually referred to as RACT II categories) are presently being pursued by various states. RACT II categories include the following source categories:

a. Graphic arts (printing)
b. Petroleum refinery fugitive emissions (leaks)
c. Pharmaceutical manufacture
d. Rubber tire manufacture
e. Surface coating of miscellaneous metal parts and products
f. Dry cleaning, perchloroethylene
g. Prevention of leaks from gasoline tank trucks
h. Petroleum liquid storage in floating roof tanks
i. Surface coating of flatwood paneling

This report presents an evaluation of the economic impacts of Ohio Administrative Code rules 3745-21-01, 04, 09, and 10. These include all of the VOC RACT II categories listed above. The study characterizes the affected industrial categories, evaluates direct and indirect compliance costs of the regulations, estimates the potential reduction in emissions, and determines the cost-effectiveness of control in terms of annualized costs per ton of reduction in emissions.

The costs of meeting the requirements are derived mainly from cost estimates provided in various U.S. EPA studies, the CTG documents, and various industry representatives and equipment suppliers. Table 1 presents a summary and comparative analysis of compliance cost estimates and potential emission reductions. It should be noted that surface coating of flatwood paneling is not included, because discussions with the Ohio EPA indicated that there were no major industrial sources in Ohio that performed this operation.

Approximately 540 facilities are affected by the RACT II regulations. Estimates of the number of affected facilities were made for several source categories. For the remaining categories, specific facilities expected to be affected by the regulations are presented in Appendix A. The perchloroethylene dry cleaners represent 61 percent of the potentially affected facilities, miscellaneous metal parts surface coating represents 16 percent, and gasoline tank trucks represent another 9 percent. External floating roof tanks account for another 8 percent of the potentially affected facilities in Ohio.

Significant emission reductions will occur in surface coating of miscellaneous metal parts, petroleum refinery leaks, and printing. These categories account for 82 percent of the total reduction in VOC emissions occurring from the application of RACT II controls. The approximate breakdown of the total RACT II VOC reductions by industrial groups is as follows:

TABLE 1

SUMMARY OF IMPACT OF IMPLEMENTING RACT II REGULATIONS ON EIGHT OHIO INDUSTRIAL CATAGORIES

INDUSTRIAL CATEGORY	NUMBER OF POTENTIALLY AFFECTED FACILITIES	ESTIMATED VOC EMISSIONS BEFORE IMPLEMENTING RACT (tons/yr)	ESTIMATED VOC EMISSIONS AFTER IMPLEMENTING RACT (tons/yr)	ESTIMATED VOC EMISSION REDUCTION DUE TO RACT (tons/yr)	COST OF RACT CONTROLS ($10^3) CAPITAL COST	COST OF RACT CONTROLS ($10^3) NET ANNUALIZED COST	AVERAGE COST EFFECTIVENESS ANNUALIZED COST PER TON VOC REDUCTION ($ per ton/yr)	CAPITAL CONTROL COST AS A PERCENT OF ANNUAL CAPITAL EXPENDITURE (%)	TOTAL ANNUAL CONTROL COST AS A PERCENT OF SALES (%)	TOTAL ANNUAL CONTROL COST AS A PERCENT OF VALUE ADDED (%)
Petroleum Refinery Leaks[a]	6	17346 to 24042	7338 to 7800	10008 to 16242	55	(1124) to (2443)	(112) to (150)	0.173	(0.058)	(0.44)
Surface Coating of Miscellaneous Metal Parts & Products[b]	87	32714	8160	24554	14167 to 232050	5868 to 74950	239 to 3050	13.4	0.123	0.276
Gasoline Tank Trucks	50	7232	3497	3735	----	387	104	0	0.006	0.09
Synthesized Pharmaceutical Manufacturing	2	23	1	22	84	28	1259	0.54	0.007	0.054
Rubber Tire Manufacturing	4	862	87	775	1014	276	356	3.74	0.042	0.094
Rotogravure & Flexographic Printing	16	8002	2182	5820	2691	5159	866	12.1	1.19	2.3
External Floating Roof Petroleum Storage Tanks	44	2415	603	1812	4700	745	411	N.A.	0.027	-
Perchloroethylene Commercial & Industrial Dry Cleaners	329	2005	835	1170	1812	109	93	-	0.06	-
Total	538	70599 to 77295	22703 to 23165	47896 to 54130	24523 to 242406	11448 to 79211	239 to 1463	12.4[c]	0.110[d]	0.387[e]

Figures presented in this table are rounded and approximated from the text for comparison purposes only. For specific data and results, refer to the individual chapters.

NOTES: Parentheses indicate net savings.
N.A. means Not Available.
- means the information is not applicable to the category.

[a] Ranges indicate emissions and cost data are functions of volatile compounds being refined.

[b] Ranges reflect the varying costs of alternate acceptable compliance strategies.

[c] Annual Capital Expenditure = $1,950,967,700

[d] Annual Sales = $72,067,273,000

[e] Annual Value Added = $20,484,238,000

Petroleum Refinery Leaks	30 percent
Surface Coating of Miscellaneous Metal Parts & Products	45 percent
Gasoline Tank Trucks	7 percent
Synthesized Pharmaceutical Manufacturing	.04 percent
Rubber Tire Manufacturing	1 percent
Rotogravure & Flexographic Printing	11 percent
External Floating Roof Petroleum Storage Tanks	3 percent
Perchloroethylene Commercial & Industrial Dry Cleaners	2 percent

As shown in Table 1, the implementation of these rules may require an estimated $242 million dollars in total capital costs, or about $79 million in total annualized costs. Assuming alternative scenarios for petroleum refineries and miscellaneous metal parts surface coating facilities, total capital and annualized compliance costs are reduced to $24.5 million and $11.5 million, respectively. It should be noted that the alternate scenarios represent greater VOC reductions for refineries and lower control costs for surface coating as shown in Table 1. Using the higher cost figure, approximately 96 percent of the total capital costs of meeting the RACT regulations are associated with the surface coating of miscellaneous metal parts. This estimate follows from two assumptions: 1) the refineries will produce more volatile products and thus have potentially higher emission reductions and credits; and 2) the majority of surface coating facilities will not be able to apply water-borne coatings because of either process or time constraints and will install control devices such as incinerators. The approximate percent of the total capital cost requirements associated with each industry group is:

Petroleum Refinery Leaks	0.02 percent
Surface Coating of Miscellaneous Metal Parts & Products	96 percent
Gasoline Tank Trucks	--

Synthesized Pharmaceutical Manufacturing	0.03 percent
Rubber Tire Manufacturing	0.4 percent
Rotogravure & Flexographic Printing	1 percent
External Floating Roof Petroleum Storage Tanks	2 percent
Perchloroethylene Commercial & Industrial Dry Cleaners	0.7 percent

There are no capital costs associated with gasoline tank trucks, because the regulation for this category consists of a leak testing program, which in most cases has only annual costs.

Of the total annual costs, surface coating of miscellaneous metal parts will incur the major portion (95 percent). Petroleum refineries realize a net cost saving because of the petroleum recovery credit. The ratio of annualized costs to the value of shipments is most significant for the printing industry (1.19 percent). While the degree of price increase for printed matter to consumers is difficult to predict, due to uncertainties in market and general economic conditions, there may be some impact. The approximate breakdown of the total annualized cost requirement associated with the major industry groups is:

Petroleum Refinery Leaks	(3.1) percent
Surface Coating of Miscellaneous Metal Parts & Products	94.6 percent
Gasoline Tank Trucks	0.49 percent
Synthesized Pharmaceutical Manufacturing	0.04 percent
Rubber Tire Manufacturing	0.35 percent
Rotogravure & Flexographic Printing	6.5 percent
External Floating Roof Petroleum Storage Tanks	0.94 percent
Perchloroethylene Commercial & Industrial Dry Cleaners	0.14 percent

The average cost-effectiveness (annualized cost per ton of VOC reduced) for all the affected industrial categories ranges from $239 per ton to $1,463 per ton of VOC emission reduction. This cost will depend on the control scenario used for the surface coating of miscellaneous metal parts. If the thermal incinerator scenario is used, then the overall cost effectiveness will approach the upper bound. In this scenario, the petroleum refineries are the most cost effective case and the surface coating facilities are the least cost effective case. The surface coating facilities represent the only category which may be significantly less cost effective than the average value.

In the event that the surface coating facilities can implement the lower cost water-borne coating technology, then the average cost-effectiveness for all affected industries is $239 per ton of VOC reduction. The least cost effective industry is then synthesized pharmaceutical manufacturing while refineries remain the most cost-effective category. The following categories, then, are significantly less cost-effective than the average value:

Synthesized pharmaceutical manufacturing
Rubber tire manufacturing
Rotogravure and flexographic printing
External floating roof petroleum storage tanks

1.0 INTRODUCTION

The Clean Air Act Amendments (CAAA) of 1977 required each state to demonstrate attainment with the National Ambient Air Quality Standards (NAAQS) for all areas within the state. Attainment and nonattainment areas in each state for individual pollutants are listed in the March 3 and October 5, 1978 Federal Registers. This listing is updated in subsequent Federal Registers.

The 1977 CAAA also required each state having nonattainment areas to adopt and submit for federal approval State Implementation Plans (SIP) for achieving compliance with the NAAQS by December 31, 1982, with possible extensions to 1987. SIP strategies for achieving attainment of the ozone NAAQS must incorporate regulations which reflect the application of reasonably available control technology (RACT) to existing volatile organic compound (VOC) sources for which the U.S. EPA has published control techniques guideline (CTG) documents. RACT is defined as the lowest emission limit that a particular source is capable of meeting by the application of control technology that is reasonably available, considering technological feasibility and economic reasonableness.

By 1978, CTGs covering fifteen VOC source categories were published. Ohio regulations promulgated in response to these guidelines remain in effect and are referred to as RACT I regulations. A second group of CTG documents was published during 1978. The resulting regulations, promulgated in Ohio as Administrative Code rules 3745-21-01, 04, 09, and 10, are referred to as RACT II. The applicable portions of the RACT II rules are presented in Appendix B. RACT II expands VOC emission control requirements for three source categories addressed in RACT I, namely petroleum refining, surface coating of metals, and petroleum storage. RACT II controls for petroleum refining are aimed at reducing leaks, which are not a specific concern in RACT I. RACT II controls for surface coating of metal products increases the number of processes covered by RACT requirements. RACT II controls for petroleum storage pertain to tanks with external floating roofs, while RACT I addressed fixed roof storage tanks. RACT II regulations additionally address the following six source categories not included in RACT I:

- The gravure and flexography segments of the graphic arts industry;
- The manufacture of synthesized pharmaceutical products;
- The manufacture of pneumatic rubber tires;
- Leaks from gasoline tank trucks;
- Perchloroethylene dry cleaning systems; and
- Surface coating of flatwood paneling.

The CAAA of 1977 requires only that RACT be applied to a state's nonattainment areas for a given pollutant. However, it is recognized that VOC emissions from outside nonattainment areas can contribute to and aggrevate ozone-related problems in urban nonattainment areas. The Ohio EPA has promulgated RACT II regulations that apply to all existing sources of a specified industry category that are located within 18 relatively more urbanized Ohio counties, and to facilities in the same industry category that are located elsewhere in Ohio and have potential VOC emissions of at least 100 tons per year. The 18 designated urbanized Ohio counties are: Butler, Clermont, Cuyahoga, Franklin, Greene, Hamilton, Lake, Lorain, Lucas, Mahoning, Medina, Montgomery, Portage, Stark, Summit, Trumbull, Warren, and Wood counties. These and other Ohio counties which are classified as nonattainment for ozone are shown in Figure 1-1.

Section 172 (b)(9) of the CAAA requires that an analysis be performed to determine the economic impact of RACT regulations on affected industries. This report is intended to satisfy the federal requirement for Ohio's RACT II regulations. Of the nine source categories detailed above, affected sources were found in Ohio for all except surface coating of flatwood paneling. Therefore, this report does not discuss this source category.

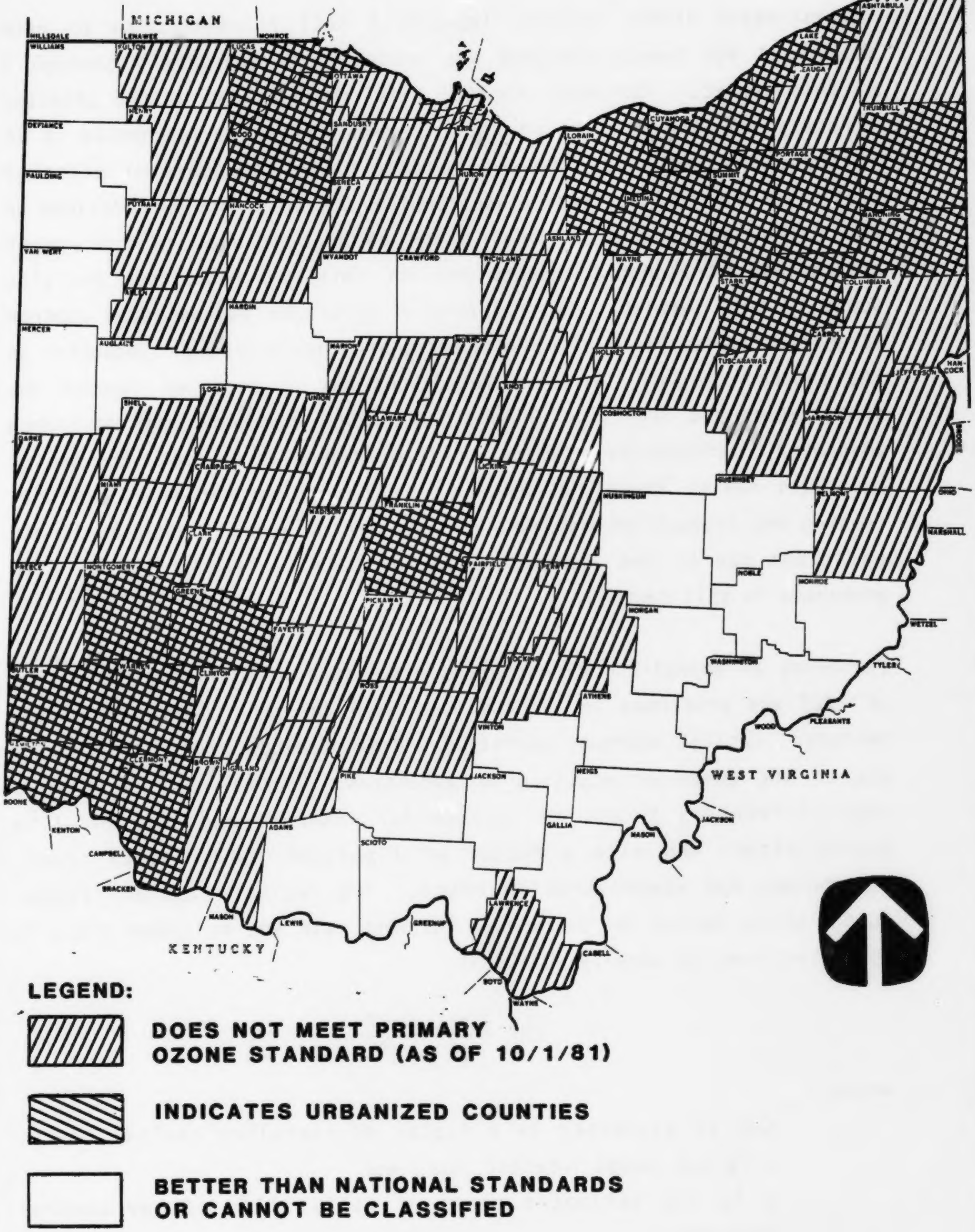

MICHIGAN
KENTUCKY
WEST VIRGINIA
LUCAS
WOOD
OTTAWA
CUYAHOGA
LAKE
ASHTABULA
GEAUGA
TRUMBULL
PORTAGE
SUMMIT
MEDINA
LORAIN
MAHONING
STARK
COLUMBIANA
FRANKLIN
MONTGOMERY
GREENE
BUTLER
WARREN
CLERMONT
HAMILTON
LEGEND:
DOES NOT MEET PRIMARY OZONE STANDARD (AS OF 10/1/81)
INDICATES URBANIZED COUNTIES
BETTER THAN NATIONAL STANDARDS OR CANNOT BE CLASSIFIED

FIGURE 1-1

EIGHTEEN URBANIZED AND OTHER OHIO COUNTIES DESIGNATED AS NONATTAINMENT FOR OZONE

Dames & Moore

The estimated direct economic impacts of RACT II regulations on each associated VOC source category are presented in Chapters 2 through 9 of this report. For each chapter, brief descriptions of the affected industry and the associated RACT II regulation are presented in an introductory section. The development of an inventory of affected facilities and their estimated uncontrolled VOC emissions is contained in the following section. Model plant parameters used in subsequent estimations of economic impacts and VOC emissions reductions are also found in this section. Descriptions of alternate VOC emission control strategies available to affected sources are then provided. Depending on the source category, emission reductions may be realized through the installation and operation of emission control equipment such as carbon adsorbers, incineration systems, or leak prevention devices, the use of materials having lower VOC content, or the implementation of periodic testing and inspection programs. The estimated annual reduction in VOC emissions due to the implementation of RACT II regulations is also presented in this section.

Estimates of annualized direct costs associated with the implementation of RACT are presented in Section 4 of each chapter. Annualized costs include: capital charges, operating and maintenance costs, and credits due to VOC compound recycling or retention. Capital charges cover a capital recovery factor to account for interest and straight-line depreciation, and also a factor of 4 percent for property taxes, insurance, and administrative costs. The capital recovery factor (CRF), which depends on the annual interest rate and equipment life, is estimated from the annuity equation:

$$CRF = \frac{r(1 + r)^n}{(1 + r)^n - 1}$$

where:

CRF is expressed as a factor of installed capital costs;
r is the annual interest rate; and
n is the estimated years of useful life of any control equipment.

An annual interest rate of 12 percent was utilized for all affected industry categories. This percentage is assumed to be representative of the average cost of capital, in view of current lending rates and the spectrum of borrowing needs of large and small businesses affected by the RACT II regulations. Technical references utilized in the presentation of information are provided at the end of each chapter.

Chapter 10 qualitatively addresses indirect effects on Ohio's economy resulting from the affected sources complying with the RACT II regulations. Examples of indirect effects include changes in prices, employment, and energy consumption. Appendix A contains a list of the facilities identified as potentially affected by the regulations. Appendix B to this report contains Ohio's RACT II regulations, and information regarding regulation compliance schedules; geographic applicability; and required testing methods and procedures.

2.0 PETROLEUM REFINERY FUGITIVE EMISSIONS (LEAKS)

2.1 Introduction

The Ohio EPA has adopted a regulation for controlling volatile organic compound (VOC) emissions from equipment leaks in petroleum refineries. This regulation addresses various potential leak sources, including components such as pump seals, compressor seals, pipeline valves, flanges, pressure relief valves, and process drains. There are many potential leak sources from these components--over 100,000 in a large refinery. It should be understood, however, that only a small percentage of leaking components accounts for the majority of leak emissions.

Most of the components maintain a sealing effect through proper mating of the sealing surfaces by means of compressed packing gaskets, machined surfaces (as in mechanical seals), and seats (as in pressure relief devices). The leaks occur when the ability to seal is reduced through improper design, construction, installation, maintenance, or deterioration under normal operating conditions.

The proposed regulation sets down rules requiring periodic monitoring for leaks, repair of monitored leaks exceeding 10,000 ppm organic compounds, maintenance of a monitoring log, and quarterly reporting of monitoring efforts. Specifically, the regulation requires (a) yearly monitoring of all pump seals, pipeline valves in liquid service and process drains; (b) quarterly monitoring of all compressor seals, pipeline valves in gas service, and pressure relief valves in gas service; (c) monthly monitoring of all pump seals by visual methods. The regulation requires that if a leak is identified as a result of the monitoring program and found to have a VOC concentration exceeding 10,000 ppm, reasonable efforts should be made to repair it within fifteen days. A monitoring log should be maintained, and the components found leaking during the monitoring process should be monitored again within five days after the repair of the leak. The regulation exempts any pressure relief devices which are connected to an operating flare header, vapor recovery devices, valves which are not reasonably accessible, valves which are located in pipelines containing kerosene or heavier liquids, storage tank valves, and valves which are not externally regulated.

2.2 Inventory of Affected Facilities

There are six affected petroleum refineries in Ohio. The geographic location and the crude refining capacities of these refineries are given in Table 2-1. As the table indicates, the crude refining capacities of the affected refineries vary from 20,000 barrels per calender day (b/cd) to 168,000 b/cd, with an average capacity of 90,120 b/cd.

In order to quantify the fugitive VOC emissions from the six affected refineries, the number of various components that can potentially contribute to fugitive VOC emissions must be known. However, since the specific component inventories for the affected refineries were not available, a model plant approach was used to estimate the number of components and the fugitive VOC emissions.

The refining capacity distribution of the affected refineries, as presented in Table 2-1, indicates that two model plants should be formulated to represent the large refineries (capacity range: 120,000-168,000 b/cd) and the small refineries (capacity range: 20,000-64,000 b/cd). Based on the average of the refining capacities of the affected large and small refineries, the crude refining capacities of the two model plants should be approximately 138,000 b/cd and 43,000 b/cd, respectively. However, difficulty was encountered in estimating the number of components (seals, valves, flanges, etc.) in model refineries with the above capacities. The only component inventory data available in the published reports[1] are for either a 100,000 b/cd capacity refinery or a 330,000 b/cd capacity refinery. It is not possible to extrapolate data for a different size refinery because the number of sources such as pump seals and valves are independent of the size of the process units.[2] The number of sources is a function of the complexity of the refinery unit rather than the unit's capacity.

TABLE 2-1. PETROLEUM REFINERIES IN OHIO

Facility	City	County	Crude[a] Capacity (b/cd)
Standard Oil of Ohio	Lima	Allen	168,000
	Toledo	Lucas	120,000
Sun Co.	Toledo	Lucas	125,000
Ashland Petroleum	Canton	Stark	64,000
	Findlay	Hancock	20,000
Gulf Oil Co.	Cleves	Hamilton	43,700
	Toledo[b]	Lucas	-

[a] Reference 3.

[b] Not currently in operation.

Therefore, the use of two model plants to represent the affected Ohio refineries could introduce significant error into the analysis, since the only way to develop the component inventories for the refineries was to extrapolate from the source data available in the published reports. To avoid such an uncertain analysis, it was decided to use only one model refinery of 90,100 b/cd capacity (average capacity of the affected refineries). In size, this model plant is comparable to the model plant (100,000 b/cd) used in an EPA study.[1] Therefore, the component inventory presented in this EPA study was assumed to represent the average number of sources per refinery for the affected Ohio refineries.

The component inventory and leak distribution for the 100,000 b/cd model refinery are shown in Table 2-2. It is clear that valves are the most significant source of VOC emissions, emitting about 75 percent of the total refinery leak emissions.

Table 2-3 presents the estimates of the fugitive VOC emissions from various components in the model refinery. These emissions were estimated by using the emission factors developed by Radian Corporation for the U.S. EPA.[5] The Radian Study determined emission factors for various components in different stream services. Emissions can be calculated for two different types of refineries, weighted towards heavy streams (Case I) or lighter streams (Case II). As can be seen from Table 2-3, valves account for approximately three-fourths of all the leak emissions in the refinery.

2.3 Alternative VOC Control Measures

The control techniques available to reduce fugitive VOC emissions from various refinery components include a conscientious monitoring program and a maintenance program ranging from simple repair work (tightening the bolts, lubrication, etc.) to the replacement of parts (new mechanical seals for pumps and compressors, repacking or replacing valves, etc.).

TABLE 2-2. EQUIPMENT LEAK DISTRIBUTION IN THE MODEL REFINERY

Component	Number of Components[a]	Components With 90% of Emissions[a]	Percent of Total Refinery Leak Emissions	Components With Emissions Greater than 10,000 ppm[b]
Pipeline Valves	25,500	765	75	1640
Pump seals	250	23	5	30
Compressor	14	2	2	2
Flanges	64,000	640	4	-
Process Drains	1,400	56	3	84
Pressure Relief Valves	130	7	11	34

[a] Reference 1.

[b] Based on Reference 5.

TABLE 2-3. VOC EMISSIONS FROM EQUIPMENT LEAKS IN THE MODEL REFINERY

Source Type	Number of Sources[a]		Emission Factor (lb/hr/source)	Emissions (tons/yr)		Percent of Total Leak Emissions	
	Case I	Case II		Case I	Case II	Case I	Case II
Valves							
Gas/Vapor	2,550	7,650	.059	659	1,977	23	49
Light Liquid/Two Phase	12,750	10,200	.024	1,340	1,072	46	27
Heavy Liquid	10,200	7,650	.0005	22	17	1	0
Pump Seals							
Light Liquid	100	150	.25	110	164	4	4
Heavy Liquid	150	100	.046	30	20	1	0
Compressor Seals							
Hydrocarbon Service	7	10	1.4	43	61	1	2
Hydrogen Service	7	4	.11	3	2	0	0
Flanges	64,000	64,000	.00056	157	157	5	4
Drains	1,400	1,400	.07	429	429	15	11
Relief Valves	130	130	.19	108	108	4	3
Total Emissions	-	-	-	2,901	4,007	100	100

[a] The division of components into service categories and service mix was derived from information contained in Reference 5. The service mix in Case I is weighted toward heavy product streams. The mix in Case II is weighted toward lighter product streams.

VOC leaks from valves can be reduced by instituting a conscientious montoring and maintenance program. VOC leaks can be monitored with portable hydrocarbon detectors, and the leaking valves can normally be repaired while in service by simple maintenance work such as tightening packing glands or injecting grease. Valves that cannot be maintained or repaired while in service should be identified and repaired during the next process unit shutdown and/or turnaround. Packing replacement or valve replacement is most feasible during shutdowns/turnarounds.

The leak frequency and emission factor for flanges (Table 2-3) are both very low. Existing methods of flange installation and testing coupled with visual inspection appear to be effective in minimizing VOC emissions.[2] Therefore, no additional control is recommended for flanges.

VOC emissions from pump seals can be reduced through periodic monitoring with hydrocarbon detectors and repair (tightening of packing gland, replacement of packing, replacement of seal, etc.). In the case of packed seals and single mechanical seals, VOC emissions can be reduced by using double mechanical or tandem mechanical seals with a barrier fluid (seal oil). VOC emissions from a leaking compressor seal can also be reduced by using a double mechanical seal with a barrier fluid (seal oil). The barrier fluid circulates through the seal area and absorbs the compressed gas. Where practical, this fluid can be circulated to a reservoir equipped with a closed degassing vent system. The vent system can be routed back to the compressor intake, or it can be connected to a control device such as an incinerator or a vapor recovery system.

Finally, VOC emissions from pressure relief valves can also be controlled by periodic monitoring and routine maintenance.

Table 2-4 presents the estimated control efficiencies of instituting a monitoring and maintenance program for controlling VOC emissions from refinery component leaks. The potential VOC emission reductions and the controlled emission levels for the model plant are developed in Table 2-5 for a 100,000 b/cd refinery. With a Case I (heavy) stream distribution, a VOC emission reduction of 1,668 tons/yr could be expected as a

TABLE 2-4. FUGITIVE VOC EMISSIONS SOURCES AND APPLICABLE CONTROL OPTIONS

Source	Control	% Reduction[a]
Valves		
Gas/Vapor	Conscientious monitoring and maintenance program (simple repairs, packing replacement, valve replacement)	89
Light Liquid/Two Phase		67
Heavy Liquid		0
Pump Seals		
Light Liquid	Conscientious monitoring and maintenance program (simple repairs, installation of double mechanical seals with barrier fluid)	64
Heavy Liquid		24
Compressor Seals		
Hydrocarbon	Conscientious monitoring and maintenance program (simple repairs, installation of double mechanical seals with barrier fluid)	79
Hydrogen		85
Flanges	No control	0
Pressure Relief Valves	Conscientious monitoring and maintenance program (simple repairs, installation of rupture discs)	64

[a] Based on Reference 4, pp. 421-440, and Reference 2.

TABLE 2-5. EMISSION DATA FOR A MODEL REFINERY

Source Type	Uncontrolled Emissions (tons/yr)[a] Case I	Uncontrolled Emissions (tons/yr)[a] Case II	Control Efficiency[b] (%)	Emission Reduction (tons/yr)[c] Case I	Emission Reduction (tons/yr)[c] Case II	Controlled Emission Level (tons/yr)[d] Case I	Controlled Emission Level (tons/yr)[d] Case II
Valves							
Gas/Vapor	659	1,977	89	587	1,760	72	217
Light Liquid/Two Phase	1,340	1,072	67	898	718	442	354
Heavy Liquid	22	17	0	0	0	22	17
Pump Seals							
Light Liquid	110	164	64	70	105	40	59
Heavy Liquid	30	20	24	7	5	23	15
Compressor Seals							
Hydrocarbon Service	43	61	79	34	48	9	13
Hydrogen Service	3	2	85	3	2	0	0
Flanges	157	157	0	0	0	157	157
Drains	429	429	0	0	0	429	429
Pressure Relief Valves	108	108	64	69	69	39	39
Total	2,901	4,007	-	1,668	2,707	1,233	1,300

[a] Table 2-4

[b] Table 2-3

[c] Potential emission reduction for all six affected facilities is 10,008 tons/yr for a Case I (heavy) service mix assumption and 16,242 tons/yr for a Case II service mix assumption.

[d] Potential controlled emission levels for all six affected facilities is 7338 tons/yr for a Case I service mix assumption and 7800 tons/yr for a Case II service mix assumption.

result of the monitoring and maintenance program. A refinery of the same size with a Case II (light) stream distribution could achieve a 2,707 tons/year reduction in VOC emissions with the implementation of the monitoring and maintenance program required under the Ohio regulation. The potential reduction for all six refineries in Ohio range from 10,008 tons/yr to 16,242 tons/yr, depending upon the stream distribution. In order to achieve the reduction levels, effective maintenance must be performed expeditiously (for example, within 15 days).

2.4 Cost Analysis

The major emphasis of the Ohio regulation for control of leak emissions from oil refineries is on a monitoring and maintenance program. This program is labor intensive. The labor requirements for such a program were based on the U.S. EPA estimate, which in turn is based on the Control Technology Guideline for petroleum refinery leaks.[1] The CTG manpower requirements were modified to conform to the slightly decreased monitoring frequency of the Ohio rule (monthly visual inspection of pump seals).

Annual cost for parts and equipment is low; the expense is principally for calibration gas, batteries and filter packs for the portable gas detector, and replacement seals for pumps and compressors. Annual costs for labor and miscellaneous parts, in January 1981 dollars, are presented in Table 2-6.

The monitor itself is the only capital expense item for the required program. The monitor used for the analysis, a Foxboro/Wilks, Inc., OVA-108 portable gas detector, is similar to that used by the EPA in developing the CTG and conforms to the Ohio regulation monitor specifications. Two monitors were used in the capital cost estimate, one to serve as a backup unit. The installed capital cost and annualized capital charges are presented in Table 2-7.

The annualized capital charges cover a capital recovery factor to account for interest and depreciation. They also cover a factor for property taxes, insurance, and administrative costs. The capital re-

TABLE 2-6. ANNUAL MONITORING AND MAINTENANCE COSTS FOR A MODEL PETROLEUM REFINERY[a]

Source	Costs for Parts and Instrument Maintenance (10^3 $)	Monitor Labor[b] (10^3 $)	Maintenance Labor[b] (10^3 $)	Total (10^3 $)
Valves	-	43.3	26.4	69.7
Pump Seals	5.0	1.8	64.3	71.1
Compressor Seals	5.0	.5	2.1	7.6
Flanges[c]	-	-	-	-
Drains	-	1.2	9.0	10.2
Pressure Relief Valves	-	3.7	-	3.7
Monitor Device[d]	3.3	-	-	3.3
Total	13.3	50.5	101.8	165.6

---

[a] 100,000 b/cd.

[b] Based on CTG labor requirements at $27/hr (reference 5 update). This includes administrative and support costs.

[c] Included in routine maintenance.

[d] Reference 6 updated with M & S equipment cost indices. Though not an emissions source, the monitor has maintenance charges associated with it such as calibration gas, batteries, and filter packs.

TABLE 2-7. INSTALLED CAPITAL COSTS FOR MONITOR EQUIPMENT AT A MODEL REFINERY

Capital Cost (10^3 \$)[a]	9.20
Capital Charge Factor (%)[b]	28.32
Annualized Capital Charges (10^3 \$)	2.62

[a] Reference 7

[b] Assumed equipment life of 6 years, 12% interest. This includes 4 percent of installed capital cost for taxes and insurance.

covery factor was estimated to be 24.3 percent of the capital costs based on an interest rate of 12 percent and a useful equipment life of 6 years. The factor for property taxes, insurance and administrative costs was assumed to be 4 percent of the capital costs. Table 2-7 presents the installed capital costs and the annualized capital charges for the model refinery.

Table 2-8 summarizes the control cost estimates for all of the affected refineries. These costs are developed for both types of stream distributions. The total installed capital cost for both cases is $55,000. The corresponding net annualized costs, after considering the annual petroleum savings, were estimated to be approximately $1.12 million net credit for a Case I (heavy) stream distribution and $2.44 million net credit for a Case II (light ends) stream distribution. Based on total reductions of 10,008 tons/yr and 16,242 tons/yr of VOC for Cases I and II, respectively, the cost-effectiveness of control was estimated to be $112 saved per ton of reduction for a Case I stream distribution and $150 saved per ton of reduction for a Case II stream distribution.

TABLE 2-8. COST SUMMARY FOR PETROLEUM REFINERY VOC CONTROL EQUIPMENT IN OHIO (10^3 $)

	Case I	Case II
Number of affected facilities	6	6
Installed capital costs[a]	55	55
Annualized capital charges[a]	16	16
Annual monitoring & maintenance costs[b]	994	994
Annual petroleum savings[c]	(2118)	(3437)
Net annualized cost (credit)	(1124)	(2443)
Cost effectiveness ($ per ton reduction)	(112)	(150)

Note: Parentheses indicate credits.

[a] Based on Table 2-7.

[b] Based on Table 2-6.

[c] The credit was calculated at $32/bbl, density of 7.2 lb/gal, based on Reference 8. The total reductions were: Case I - 10,008 tons/yr, Case II - 16,242 tons/yr, from Table 5.

2.5 References

1. "Control of Volatile Organic Compound Leaks from Petroleum Refinery Equipment," EPA-450/2-78-036, U.S. EPA, Research Triangle Park, North Carolina, June 1978.

2. "Assessment of Atmospheric Emissions from Petroleum Refining: Volume 3. Appendix B," EPA-600/2-80-075C, U.S. EPA, Research Triangle Park, North Carolina, April 1980.

3. Oil and Gas Journal. Vol. 79, No. 13. March 30, 1981.

4. "Emission Factors and Frequency of Leak Occurrence for Fittings in Refinery Process Units," EPA-600/2-79-044, U.S. EPA, Research Triangle Park, North Carolina, February 1979.

5. "Assessment of Atmospheric Emissions from Petroleum Refining: Volume I. Technical Report," EPA-600/2-80-075, U.S. EPA, Research Triangle Park, North Carolina, April 1980.

6. "Proceedings: Symposium on Atmospheric Emissions from Petroleum Refineries (November 1979, Austin, TX)," EPA-600/9-80-013, U.S. EPA, Research Triangle Park, North Carolina, March 1980.

7. "RACT and LAER Control Cost Estimates for Selected Petrochemical Manufacturing and Petroleum Refining VOC Source Categories," Engineering Science, McLean, Virginia, February 1980, revised March 1980.

8. Personal communication with a representative of Foxboro/Wilks, Inc., South Norwalk, Conn., July 1981.

9. Personal communication with Darryl Bruckert of Union Oil, Lemont, Illinois, July 1981.

3.0 SURFACE COATING OF MISCELLANEOUS METAL PARTS AND PRODUCTS

3.1 Introduction

Surface coating of miscellaneous metal parts and products includes all the metal surface coating operations under SIC Codes 33 through 41, with the exception of the surface coating of cans, coils, magnet wire, automobiles and light duty trucks, metal furniture and large appliances. These surface coating operations have been addressed separately by the U.S. EPA in its previously published Control Technique Guideline (CTG) documents. The miscellaneous metal parts and products category, therefore, includes several small- to medium-size industries with many dissimilarities. These various industrial categories are listed in Table 3-1.

Processes used for the surface coating of miscellaneous metal parts and products include dip coating, flow coating, and several kinds of spray coating. The choice depends on such variables as the type of coating to be applied, the size and the shape of the product, the production rate, and the desired final appearance of the coated product. In dip coating, the part is dipped into a tank of coating material. The tank is typically equipped with circulating pumps and filters to keep the paint well mixed and free of impurities. Paint viscosity and temperature, which directly affect the coating characteristics, are monitored closely. In flow coating, paint is poured onto the product and excess paint is collected in a settling basin for filtration and recirculation. In spray coating, paint is atomized and sprayed on the surface to be coated by a conventional air spray gun, an airless spray gun, or an electrostatic system. Overspraying can waste considerable quantities of paint, and paint viscosity is an important factor in this regard, since it affects atomization. Methods of adjusting viscosity include changing the solvent content and controlling the paint temperature.

TABLE 3-1. LIST OF INDUSTRIAL CATEGORIES COVERED UNDER MISCELLANEOUS METAL PARTS AND PRODUCTS

- Large farm machinery (harvesting, fertilizing and planting machines, tractors, combines, etc.)
- Small farm machinery (fans, mixers, blenders, crock pots, dehumidifiers, vacuum cleaners, etc.)
- Commercial machinery (computers and auxiliary equipment, typewriters, calculators, vending machines, etc.)
- Industrial machinery (pumps, compressors, conveyor components, fans, blowers, transformers, etc.)
- Fabricated matal products (i.e., metal covered doors, frames)
- Any other industrial category which coats metal parts or products under the Standard Industrial Calssification Code of Major Group 33 (primary metal industries), Major Group 34 (fabricated metal products), Major Group 35 (non-electrical machinery), Major Group 36 (electrical machinery), Major Group 37 (transportation equipment), Major Group 38 (miscellaneous instruments), and Major Group 39 (miscellaneous manufacturing industries).

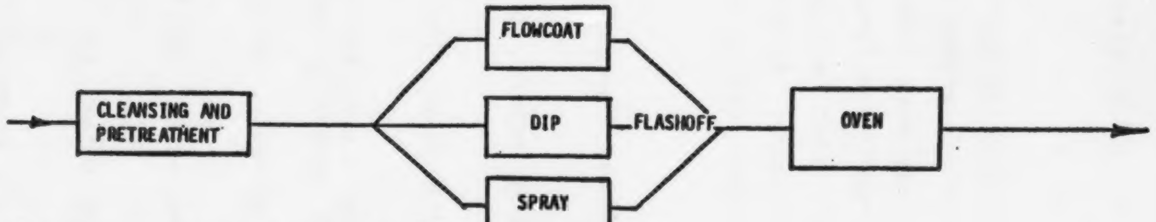
Source: Reference 1

Figure 3-1 shows flow diagrams for the processes used in coating miscellaneous metal parts. The major sources of VOC emissions from the coating operations are the coating and flashoff areas and the baking oven or air drying area. Air or forced air drying is generally used for operations involving large equipment (industrial, construction, transportation equipment) or heat sensitive materials (rubber tubing, plastic parts, etc.) that preclude the use of ovens.

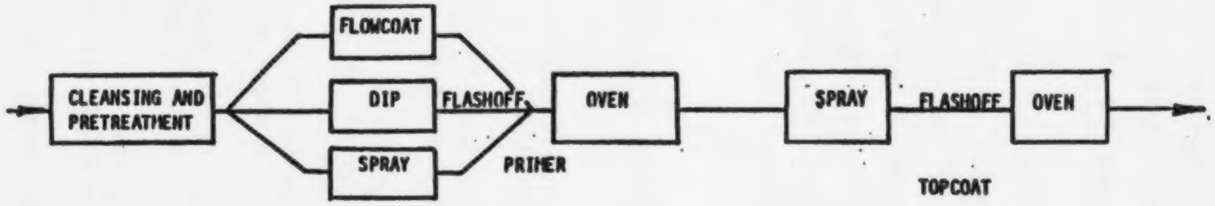
The Ohio EPA regulation on the control of VOC emissions from the surface coating of miscellaneous metal parts and products requires either the use of control equipment or the application of coatings with reduced solvent content. When a control device is used, the regulation further requires a maximum reasonable capture efficiency based on good engineering design and at least 90 percent control efficiency. Alternatively, the regulation requires plants to use low-solvent coating with the following solvent contents:

- 4.3 pounds per gallon of coating, excluding water, for a clear coating
- 4.0 pounds per gallon of coating, excluding water, for a zinc-rich primer coating
- 3.5 pounds per gallon of coating, excluding water, for an extreme performance coating
- 3.5 pounds per gallon of coating, excluding water, for any coating that is dried at temperatures not exceeding 200°F
- 5.0 pounds per gallon of coating, excluding water, for the interior coating of a steel pail or drum
- 3.5 pounds per gallon of coating, excluding water, for the exterior coating of a steel pail or drum
- 3.0 pounds per gallon of coating, excluding water, for any coating other than those discussed above

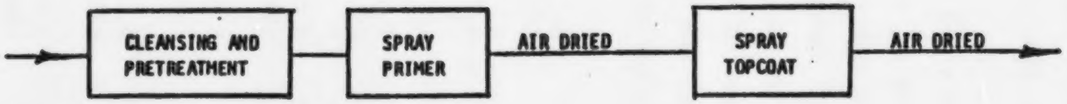
The following miscellaneous metal coating operations are exempted from the regulation: (a) the application of an exterior coating to marine vessels; (b) the application of an exterior coating to airplanes; (c) the application of a refinishing coating to motor vehicles; (d) the


CLEANSING AND PRETREATMENT
FLOWCOAT
DIP
SPRAY
FLASHOFF
OVEN

a) Conveyorized or batch single coat operation.


CLEANSING AND PRETREATMENT
FLOWCOAT
DIP
SPRAY
FLASHOFF
PRIMER
OVEN
SPRAY
FLASHOFF
OVEN
TOPCOAT

b) Conveyorized two-coat operation.


CLEANSING AND PRETREATMENT
SPRAY PRIMER
AIR DRIED
SPRAY TOPCOAT
AIR DRIED

c) Manual two-coat operation air dried.

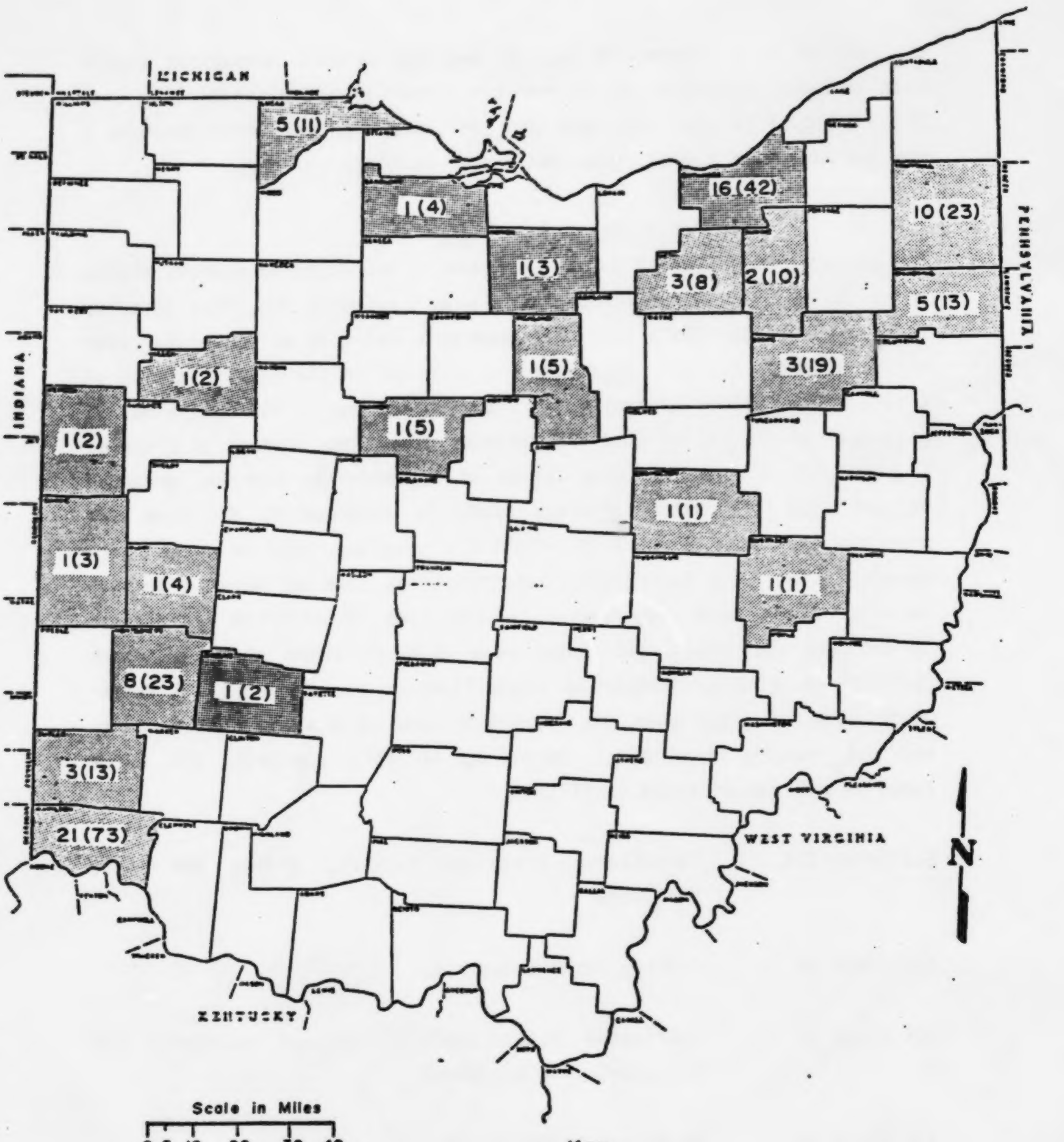
FIGURE 3-1 TECHNIQUES COMMONLY USED IN COATING MISCELLANEOUS METAL PARTS AND PRODUCTS

application of a customized topcoat and any related customized single coat to motor vehicles, if the maximum number of motor vehicles is less than thirty-five per day; and (e) any coating line which employs a maximum amount of ten or fewer gallons of coatings per day.

3.2 Inventory of Affected Facilities

The inventory of affected facilities--and of VOC emission sources within these facilities--was developed mainly by reviewing the Ohio emission inventory records. Data thus developed were verified by contacting some of the affected plants. This exercise resulted in the identification of a total of 87 affected facilities with 267 sources of VOC emissions. A geographical distribution of the affected plants and sources is given in Figure 3-2. A condensed compilation of the affected sources, arranged by the type of coating process used, is arranged by SIC code and presented in Table 3-2. A two-digit SIC code was used in cases where several three- and four-digit classifications covered under a primary two-digit code were represented in the list of affected facilities. Three- and four-digit SIC codes were used in cases where only one facility in a major industrial classification was affected. A three-digit code was used when the four-digit code of the affected facility was not readily available. According to this approach, SIC codes comprise all the affected facilities:

SIC Group 254	Partitions, shelving, lockers, office and store furniture
SIC Group 33	Primary metal industries
SIC Group 34	Fabricated metal products, except machinery and transportation equipment
SIC Group 35	Machinery except electrical
SIC Group 36	Electrical and electronic machinery, equipment and supplies


MICHIGAN
INDIANA
PENNSYLVANIA
WEST VIRGINIA
KENTUCKY
N
5(11)
1(4)
16(42)
10(23)
1(3)
3(8)
2(10)
5(13)
1(2)
1(5)
3(19)
1(2)
1(5)
1(1)
1(3)
1(4)
1(1)
8(23)
1(2)
3(13)
21(73)
Scale in Miles
0 5 10 20 30 40

Key

A (B) = Number of Plants (Number of Sources)

FIGURE 3-2 GEOGRAPHICAL DISTRIBUTION OF AFFECTED MISCELLANEOUS METAL COATING FACILITIES

TABLE 3-2. ESTIMATED NUMBER OF AFFECTED SOURCES IN MISCELLANEOUS METAL PARTS AND PRODUCTS CATEGORY

SIC Code	Total Number of Affected Plants	Flow Coating Process		Dip Coating Process		Spray Coating Process		Total Number of Affected Sources
		Number of Sources	Average ACFM[a]	Number of Sources	Average ACFM[a]	Number of Sources	Average ACFM[a]	
254	1	-	-	-	-	1	10,000	1
33	6	-	-	-	-	10	14,500	10
34	38	-	-	3	3,720	117	32,100	120
35	11	1	2,150	2	1,620	30	35,900	33
36	12	3	48,250	11	2,830	24	19,300	38
37	17	1	48,800	2	6,630	57	9,920	60
384	1	-	-	-	-	2	3,500	2
5085	1	-	-	-	-	3	6,500	3
TOTAL	87	5	41,900	18	3,500	244	24,600	267

[a] Represents the average exhaust gas flow rate in actual cubic feet per minute (acfm) per source.

SIC Group 37	Transportation equipment
SIC Group 384	Surgical, medical, and dental instruments and supplies
SIC Group 5085	Industrial supplies

As the data in Table 3-2 indicate, SIC codes 34 through 37 cover most of the affected facilities (90 percent) and approximately 91 percent of the affected VOC sources are related spray coating operations. Average exhaust gas flow rates presented in the table for different SIC codes were derived by using the actual flow rate values of the affected sources. In identifying the data presented in Table 3-2, it was found that for some sources the coating process (spray, dip, or flow) was not indicated in the state inventory. In such cases, the total number of sources using a particular coating process was estimated by extrapolating the data on sources whose coating process was described.

Table 3-3 presents the VOC emission data for the affected sources. The uncontrolled VOC emssions from the 87 affected facilities total 32,714 tons/year. Approximately 96 percent of the emissions can be attributed to spray coating operations.

3.3 Alternative VOC Control Measures

Two principal options for controlling VOC emissions from miscellaneous metal surface coating operations are the use of low-solvent coatings and add-on control devices, such as carbon adsorbers and incinerators. Low-solvent coatings mainly include water-borne coatings, higher-solids coatings, and powder coatings. The applicable control technologies and their VOC control efficiencies are summarized in Table 3-4. The following paragraphs briefly discuss their advantages and limitations.

3.3.1 Water-borne Coatings

Water-borne coatings are one of the most preferred control options for miscellaneous metal coaters, mainly because the application character-

TABLE 3-3. UNCONTROLLED VOC EMISSIONS FROM THE AFFECTED MISCELLANEOUS METAL COATING OPERATIONS

SIC Code	Number of Affected Plants	Uncontrolled VOC Emissions (tons/year)			Total
		Flow Coating	Dip Coating	Spray Coating	
254	1	-	-	96	96
33	6	-	-	1,761	1,761
34	38	-	139	24,092	24,231
35	11	11	44	966	1,021
36	12	278	489	1,460	2,227
37	17	24	316	2,937	3,277
384	1	-	-	38	38
5085	1	-	-	63	63
TOTAL	87	313	988	31,413	32,714

TABLE 3-4. TECHNIQUES FOR CONTROLLING VOC EMISSIONS FROM MISCELLANEOUS METAL SURFACE COATING OPERATIONS

Technique	Application	VOC Emission Reduction, %
Water-borne coating		
Dip, flow, and spray coating	Oven-baked single coat (primer and topcoat); air-dried primer and topcoat	60-90[a]
Electrodeposition	Oven-baked single coat and primer	90-95[a]
High-solids coating (applied by spray gun)	Oven-baked single coat; air-dried primer and topcoat	50-80[a]
Powder coating (applied by spray gun)	Oven-baked single coat and topcoat	95-98[a]
Carbon adsorption	Oven-baked single coat (primer and topcoat) in application and flash-off areas; air-dried primer and topcoat in application and drying areas	90[b]
Incineration	Ovens	>90[b]

[a] These values reflect only the range of possible reduction. The actual reduction depends on the composition of the water-borne coating and replacement low-organic solvent coating, the transfer efficiency, and the relative film thickness of the two coatings.

[b] This reduction in VOC emissions is only across the control device and does not take into account the capture efficiency.

Source: Reference 2

istics of these coatings are similar to those of solvent-base coatings. Therefore, the conversion does not necessarily require extensive replacement of the existing coating equipment. The potential reduction in VOC emissions ranges from 60 to 90 percent depending upon the composition of the original organic solvent-borne coating, the composition of the replacement water-borne coating, relative transfer efficiencies, and the relative film thickness required. Although water is the major carrier in water-borne coatings, solvents are usually included to temper the evaporation rate. These solvents also infuse the coating with desired properties and provide film coalescence.

Water-borne coatings offer several advantages:[2] They are easily adaptable to existing coating lines, they permit use of existing coating equipment, they reduce toxicity and flammability, coatings can be thinned by adding water, coating equipment can be cleaned and flushed with water, and oven temperature can be decreased.

The use of water-borne coatings does pose some disadvantages, however. For example, special precautions are required to prevent corrosion of the coating equipment. Furthermore, the use of water-borne coatings with dip- or flow-coating may require additional rinse because of possible coating contamination and pH changes. And the use of water-borne coatings with electrostatic spray equipment may not be feasible because of insulation difficulties.

One other problem associated with the use of water-borne coatings is the increased drying time needed, since the water does not flash off as fast as the solvent. Because of this, production might decrease unless larger drying chambers are installed or the parts to be coated are preheated to enhance evaporation. However, either of these measures will likely increase energy consumption.

One possible way of combining a process change with the use of a low-solvent coating is to apply water-borne solvents by electrodeposition. In this process, the parts to be coated are grounded and immersed in a bath of coating. Direct current is applied to the bath, charging the paint particles, which then migrate to and deposit on the surface of the parts. The conversion to electrodeposited water-borne coatings requires new application equipment (i.e., tank, ultrafilter, rinsing stations, etc.). It does result in a high-quality coating because of high transfer efficiencies, however, and it increases protection against corrosion. The major disadvantages of conversion to electrodeposition are higher energy consumption and a large capital investment for equipment.

3.3.2 High-Solids Coatings

High-solids coatings reduce VOC emissions by virtue of a low VOC content. The solid content of high-solids coatings can be as high as 80 percent, whereas, for conventional coatings, it is about 40 percent.[2] With only minimal changes, existing coating equipment can often be used to apply high-solids coatings. The high-solids coatings can be applied by roll coating or by spraying (either with automated electrostatic techniques or manually).

Advantages of using high-solids coatings include reduced airflow rates in the spray booths and ovens and a decrease in solid and liquid wastes, both because of the reduced solvent content. Also, transfer efficiencies with these coatings are often better than with conventional solids coatings, particularly with either electrostatic spray or disc and bells. On the other hand, because high-solids coatings are more viscous, a paint heater may be needed and/or additional mechanical, thermal, or electrical energy may be required to pump and/or to sufficiently atomize the coatings. Paint cleanup could be more difficult with high-solids coatings. Also, some high-solids coatings could be toxic and might require special handling.[2]

3.3.3 Powder Coatings

Powder coating involves the application of a coat of solid particles to a surface and the subsequent melting of these solids into a smooth, continuous film. The coatings may be applied by either dip or spray coating, and the organic compound emissions are very small, between one and four percent by weight. In dry coating the part is heated and dipped in a fluidized bed of coating solids. The powder adheres to the part and may be reheated to form a smooth coating surface. An alternative method of powder dip coating is to give the powder an electrical charge, grounding the piece to be coated. The particles will rise due to repulsion and adhere to the grounded part as it is passed over or through the bed.

The powder may also be sprayed onto the part. The part is heated so the sprayed particles will adhere to it, and reheated to cause the powder to flow into a smooth coating. This method of spray application, known as dusting or flocking, is limited in the consistency of coatings that can be employed and is generally suitable only for simple shapes. An alternative method of spray application is electrostatic spraying. As the powder passes through a spray nozzle, the particles are given an electrical charges and are then attracted to the part being coated. Adjusting the voltage will tend to increase the coating thickness. Curing the part in an oven causes the coating to form a smoother finish.

The use of powder coatings would greatly reduce VOC emissions. Although some VOC could be emitted because of unblocking and crosslinking reactions during curing, solid and liquid wastes would be eliminated. In addition, the greater thicknesses of powder coatings can easily hide slight imperfections and weld masks. Energy requirements would be reduced because less circulated air would be needed, and the transfer efficiency of powder coatings is high because most of the overspray can be easily reclaimed.

A disadvantage to the use of powder coatings is that because the conversion of existing lines is not reversible, line flexibility is lost. Minimum coating thicknesses are also increased, and the quality of the finishes does not always match that of solvent-base coatings.[2]

3.3.4 Carbon Adsorption

In many cases, carbon adsorbers can be retrofitted to the process stream for VOC emission control. However, filters must be installed between spray booths and the adsorber to capture particulates, and exhaust gas from the ovens must be cooled below 150°F. These measures will prevent contamination and deterioration of the activated carbon.

Carbon adsorption is considered a viable control option for the application and flashoff areas in miscellaneous metal coating operations. Removal efficiency is approximately 90 percent across the unit. Some problems are often encountered in controlling VOC emissions from the bake oven because the thermal breakdown of the solvent can produce several compounds in low concentrations that are not easily adsorbed. Based on the conversations with some of the affected plants, carbon adsorbers, though technically feasible, are not a preferred control option because of such disadvantages as high energy usage and high capital costs.

3.3.5 Incineration

Incineration destroys the organic emissions by oxidizing them to carbon dioxide and water vapor. This may be accomplished either with direct flame, with thermal incinerators, or with catalytic incinerators. Thermal incinerators, which directly combust the gas, operate at about 1500°F. If the residence time is long enough, all of the organic compounds will be destroyed. The waste heat in the exhaust gas can in many cases be recovered and used to preheat the gas entering the incinerator. Catalytic incineration is similar to thermal incineration, except that the combustion temperature is lower. The catalyst accelerates the combustion reaction. One problem with catalytic incinerators is thermal degradation as well as natural depletion of the catalyst. As the effectiveness of the catalyst decreases, the incinerator's overall effectiveness is maintained by increasing the combustion temperature (i.e., increase the fuel usage rate). Heat recovery in catalytic incineration is limited because the exit temperature is about 1000°F (versus 1500°F for the thermal incinerator).

The potential control efficiency of incineration is about 95 percent, but the overall reduction efficiency is limited by the capture efficiency.

Incineration systems are more desirable (less costly and perhaps more efficient) than adsorption for reducing VOC emissions from the baking ovens for several reasons:[1]

1. No cooling system is required. High temperature (150° to 230°C) exhaust gases have to be cooled to 40°C or lower before entering a carbon bed.

2. VOC in the exhaust stream can provide appreciable heat energy (e.g., 350°C at 25 percent of the LEL). Thus, at significant VOC levels, auxiliary fuel use can be minimized or sometimes even eliminated by the proper use of heat exchangers.

3. Particulate and condensible matter from volatilization and/or degradation of resins may coat the carbon bed. These materials will not affect an incinerator.

Table 3-5 presents the estimates of VOC emission reductions, if all the applicable control measures were applied to affected sources individually. Control efficiencies used for this estimation were either the average of the control efficiency range given in Table 3-4 or the lower limit of the range, if the range was relatively narrow. For add-on controls (carbon adsorber, incinerators), overall control efficiency (capture and control) was assumed to be 75 percent.

3.3.6 Application of VOC Control Measures to Miscellaneous Metal Coating Operations

The miscellaneous metal parts and products category includes several industry groups with significant diversity in operations, not only among industry groups but also within the same industry group. Ideally, to accurately assess the potential for applying various alternative control measures, all the affected plants should have been contacted to discuss

TABLE 3-5. ESTIMATES OF VOC EMISSION REDUCTIONS FROM AFFECTED FACILITIES IN OHIO

	Uncontrolled Emissions	Potential Emission Reductions with Alternative Technologies (tons/yr)[a]					
SIC Code	(tons/yr)	Water-borne	Electrodeposition	High Solids[b]	Powder[b]	Adsorption	Incineration
254	96	72	86	62	91	72	72
33	1,761	1,321	1,585	1,145	1,673	1,321	1,321
34	24,231	18,173	21,808	15,750	23,019	18,173	18,173
35	1,021	765	919	628	918	765	765
36	2,227	1,670	2,004	949	1,387	1,670	1,670
37	3,277	2,458	2,949	1,818	2,298	2,458	2,458
384	38	28	34	25	36	28	28
5085	63	47	57	41	60	47	47
TOTAL	32,714	24,534	29,442	20,418	29,482	24,534	24,534

[a] The following average control efficiencies were used in estimating emission reductions: Water-borne coatings - 75%, electrodeposition - 90%, high-solid coating - 65%, powder coating - 95%, carbon adsorption - 75% (overall efficiency), incineration - 75% (overall efficiency).

[b] Reduction estimates are based on the application of high-solid and powder control technologies to only spray coating lines, since these controls are not applicable to flow and dip coating operations.

their planned control strategy based on their plant-specific operation. Because of the large number of affected plants and the financial constraints of this study, it was not possible to perform this exercise. Instead, several sample industrial plants within each of the represented SIC categories were contacted to get an indication of the control technique most likely to be used for compliance in their industry group. These industrial contacts provided the following information on the industrial approach to controlling VOC emissions from miscellaneous metal coating industry.

SIC 254. The only affected plant in this category is converting to powder coating for its miscellaneous metal coating operations. Therefore, powder coating was considered to be the applicable VOC control measure for this plant.

SIC 33. Discussions with the two affected plants in this category indicated that a thermal incinerator with heat recovery would probably be used for compliance with the VOC control regulation for miscellaneous metal coating. This technology (incinerator with heat recovery) was therefore assumed to be the applicable control measure for all the affected plants in this category.

SIC 34, 35, 36, 37 & 384. Discussions with eight affected plants in SIC categories 34, 35, 36, 37 & 384 indicated that the first preference of the affected plants in these industry groups was to convert their solvent-base spray operations to water-borne operations. However, at some plants compliance strategies based on this approach appeared to be still in the planning stage. Also, almost all the plants were reluctant to discuss the equipment changes associated with switching to water-borne coatings and the alternative control measure(s) that would be applied if water-borne coatings were not available in time to comply with the regulation. For the purpose of this study, both water-borne coatings and thermal incinerators with heat recovery were assumed to be the applicable control options for affected plants in SIC categories 34, 35, 36, 37 & 384.

SIC 5085. The only affected facility in this category indicated that a control device would be installed for achieving compliance with the regulation. But for proprietary reasons, the plant withheld more details of the applicable control device. For the purpose of this study, an incinerator with heat recovery was assumed to be the applicable control option.

Table 3-6 presents an estimate of the potential emission reductions from the miscellaneous metal coating industry in Ohio based on the application of anticipated control strategies for various industry groups. As indicated in the table, the reduction in VOC emissions is estimated to be 24,554 tons/year.

3.4 Cost Analysis

The costs of controlling VOC emissions from miscellaneous metal coating operations were estimated by considering the control technologies listed in Table 3-6 for various industrial categories. As the table indicates, the only affected plant in SIC 254 is converting to powder coating for compliance with the regulation. Therefore, the control costs for this plant were based on the use of powder coating as the control measure. For plants in other SIC categories, thermal incineration with heat recovery was the common control option considered. In addition, several plants in SIC 34, 35, 36, 37 and 384 are planning on converting to water-borne coatings to reduce their VOC emissions to the compliance levels. Therefore, for industries under these SIC categories (34, 35, 36, 37 & 384), costs were also estimated for converting to water-borne coatings.

The costs of converting to powder coating were estimated based on the data provided by the affected plant. The cost estimates for thermal incinerators were derived by updating the cost data in the EPA's Control Technique Guideline (CTG) document on miscellaneous metal coating.[1] The Chemical Engineering Plant Cost Index[3] was used to update the capital costs to June 1981 dollars, and the Bureau of Labor Statistics (BLS) indices[4] were used to update the annual costs. The

TABLE 3-6. VOC EMISSION REDUCTIONS BASED ON THE APPLICATION OF ANTICIPATED CONTROL TECHNOLOGIES

SIC Category No.	Uncontrolled VOC Emissions (tons/yr)	Selected Control Technology	Control Efficiency (%)	Potential Emission Reductions (tons/yr)	Controlled Emissions (tons/yr)
254	96	Powder coating	95	91	5
33	1,761	Thermal incinerator with heat recovery	75	1,321	440
34	24,231	Water-borne coating/thermal incinerator with heat recovery	75	18,173	6,058
35	1,021	Water-borne coating/thermal incinerator with heat recovery	75	765	256
36	2,227	Water-borne coating/thermal incinerator with heat recovery	75	1,670	557
37	3,277	Water-borne coating/thermal incinerator with heat recovery	75	2,458	819
384	38	Water-borne coating/thermal incinerator with heat recovery	75	29	9
5085	63	Thermal incinerator with heat recovery	75	47	16
TOTAL	32,714			24,554	8,160

cost estimates based on the CTG figures were compared with the cost estimates derived by using the procedure and cost data presented in an EPA cost manual[5] and with an estimate provided by one of the affected facilities. These comparisons of capital and annualized costs are shown in Figures 3-3 and 3-4, respectively.

As the figures show, CTG derived control costs were found to vary linearly with the acfm (exhaust air flow in actual cubic feet per minute). The lower range of the cost range shown is based on the estimates derived from the EPA cost manual.[5] The upper bound of the range was based on an estimate provided by one of the affected plants which had installed a thermal incinerator with heat recovery to handle 46,000 acfm. The capital costs of installing this incinerator were estimated to be approximately $2.4 million. Based on the experience with the CTG cost figures and cost figures derived from the EPA cost manual,[5] a linear relationship was assumed between the control costs and the acfm for the industrial cost estimate (upper bound of the cost range) also. An analysis of the cost data presented in Figures 3-3 and 3-4 indicates that the upper and lower bounds of the cost ranges represent approximately ±50 percent variation in the CTG cost figures. For the purposes of this analysis, it was judged reasonable to use CTG derived costs, since these costs represent the average of the minimum and maximum cost estimates presented in Figures 3-3 and 3-4.

The costs of converting to water-borne coatings were estimated by updating the cost data given in the CTG document.[1] An appropriate model plant (small, medium, large) developed by the EPA in the CTG document was used to represent the plants in each of the affected SIC categories. Efforts were made to verify CTG numbers through independent contacts. Two major difficulties were encountered in this process, however. First, since the miscellaneous metal coating category includes several completely dissimilar industry groups, a large proportion of the affected plants had to be contacted to obtain information on the equipment changes required to convert their operation to water-borne coatings. This was not possible because of the budget constraints and

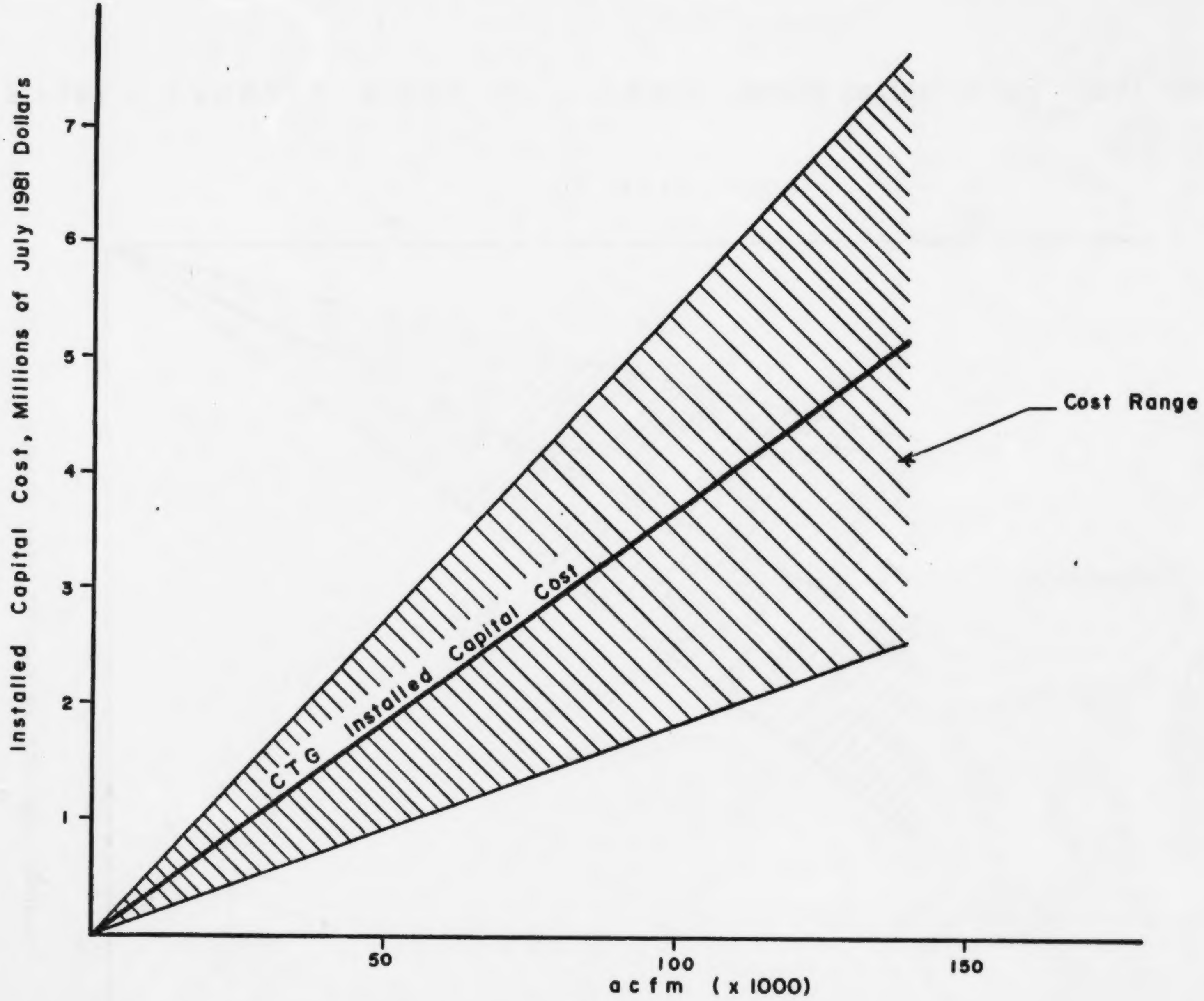


FIGURE 3-3 INSTALLED CAPITAL COST OF THERMAL INCINERATION WITH HEAT RECOVERY

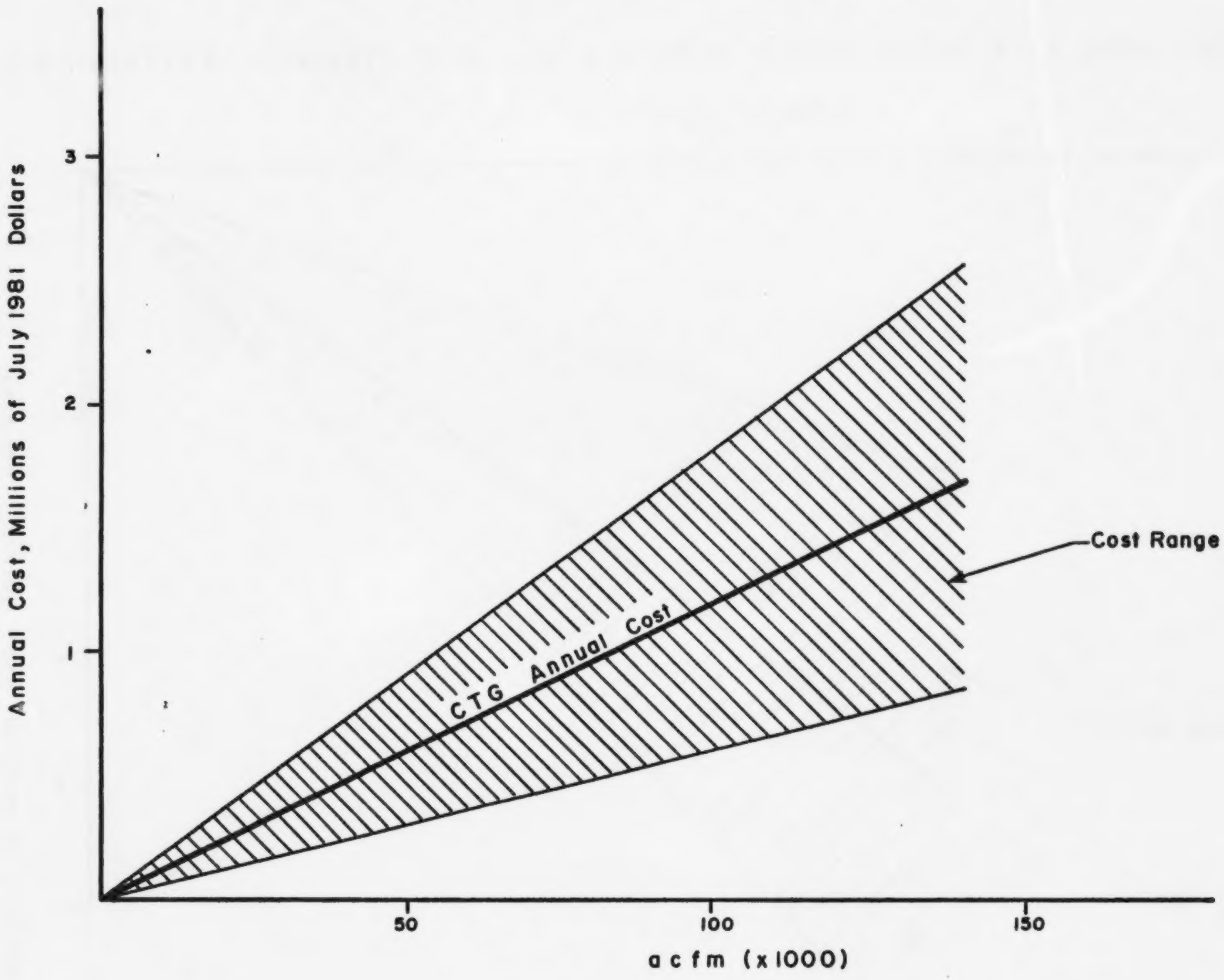


FIGURE 3-4 ANNUAL COSTS OF THERMAL INCINERATION WITH HEAT RECOVERY

also because some of the plants contacted by ETA were reluctant to discuss equipment changes. Second, the use of water-borne coatings would result in increased drying time, thus affecting plant production rate. This effect on production rate can be offset by installing larger drying chambers or by preheating the parts to be coated to enhance the evaporation of water. The costs of implementing any of the above options is again dependent upon the plant-specific operational characteristics and therefore could not be estimated because of data constraints. Since industrial input in the cost of conversion to water-borne coatings was limited, CTG-derived cost estimates were assumed to be representative of the cost impact on the affected sources in Ohio.

Table 3-7 presents the technical parameters used in developing the compliance costs per plant and for the industry-wide cost of compliance. Table 3-8 presents these compliance costs. For the purposes of developing costs for an incinerator, it was assumed that all the sources to be controlled in an affected plant would be ducted to a single incinerator. As Table 3-8 indicates, a cost range has been presented for the industry groups covered under SIC 34, 35, 36, 37 and 384. Lower cost in the range represents the compliance costs if the affected industries in these SIC categories implemented water-borne coating technology. The upper value in the cost range represents control costs if a thermal incinerator was used for compliance with the regulation. Annualized costs presented in the table include the incremental operating and maintenance costs, material costs, cost of utilities for operating the control equipment, and the fixed capital charges. Fixed capital charges include a capital recovery factor for depreciation and interest charges and a factor for insurances, taxes, and administrative overheads (four percent of the capital cost). Capital recovery factor was estimated to be 14.7 percent for conversion to water-borne coating and 17.7 percent for incinerators. The total capital costs of compliance are estimated to be approximately $14.2 million, if water-borne coatings are used for compliance by the affected facilities in SIC 34 through 38. The corresponding annualized costs are $5.9 million. However, if an incinerator is used as a means of compliance by the facilities that are

TABLE 3-7. TECHNICAL PARAMETERS USED IN ESTIMATING CONTROL COSTS

SIC Code	Number of Affected Plants	Average Number of Sources Per Plant	Average Exhaust Flow Rate Per Source (acfm)	Average Exhaust Flow Rate Per Plant	Control Technique(s)
254	1	1	10,000	10,000	Powder coating
33	6	2	14,500	29,000	Thermal incineration with heat recovery
34	3	3	32,100	96,300	Water-borne coating/ thermal incinerator with heat recovery
35	11	3	35,900	107,700	Water-borne coating/ thermal incinerator with heat recovery
36	12	3	17,830	53,490	Water-borne coating/ thermal incinerator with heat recovery
37	17	4	19,225	36,900	Water-borne coating/ thermal incinerator with heat recovery
384	1	2	3,500	7,000	Water-borne coating/ thermal incinerator with heat recovery
5085	1	3	6,500	19,500	Thermal incinerator with heat recovery

TABLE 3-8. COMPLIANCE COST ESTIMATES FOR AFFECTED MISCELLANEOUS METAL COATING PLANTS

SIC Code	Number of Affected Plants	Control Costs Per Plant[a] (x10^3\$)		Total Cost of Compliance (x10^3\$)		VOC Emission Reductions (tons/yr)	Cost-Effectiveness (\$/ton)
		Capital	Annualized[b]	Captial	Annualized		
254	1	300	100	300	100	91	1,100
33	6	1,100	350	6,600	2,100	1,321	1,590
34	38	87-3,500	48-1,100	3,306-133,000	1,824-41,800	18,173	100-2,300
35	11	87-3,900	48-1,300	957-42,900	528-14,300	765	690-1,870
36	12	87-1,900	48-650	1,044-22,800	576-7,800	1,670	345-4,670
37	17	72-1,500	28-500	1,224-25,500	476-8,500	2,458	194-3,460
384	1	36-250	14-100	36-250	14-100	29	483-3,450
5085	1	700	250	700	250	47	5,320
TOTAL				14,167-232,050	5,868-74,950	24,554	239-3,050

[a] Wherever a cost range is given, the lower value represents the cost of converting to water-borne coatings and the higher value represents the cost of using a thermal incinerator with heat recovery.

[b] The annualized costs included the operating and maintenance costs, material costs, cost of utilities, and the fixed capital charges for depreciation, interest charges, insurance, taxes, and administrative overheads.

presently planning to use water-borne coatings, the estimated capital costs of compliance would be approximately $232 million. The corresponding annualized costs would be about $75 million. The cost-effectiveness of control with the use of water-borne coatings is $239 per ton of reduction. The cost-effectiveness figure for an incinerator as the compliance technology is $3,050 per ton of reduction in VOC emissions.

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4.0 GASOLINE TANK TRUCKS

4.1 INTRODUCTION

The approach taken in the section of the Ohio RACT regulation for control of VOC emissions from gasoline tank trucks is a tank certification program of maintenance, monitoring, and reporting. The owner or operator of a gasoline tank truck is required to have each tank and its vapor collection system pass an annual leak tightness test. The regulation requires repair and retesting of the tank if it fails to pass the prescribed certification test for any reason. The regulation also establishes test procedures, record-keeping, and reporting requirements which demonstrate and document compliance.

Although the section of the regulation dealing with tank trucks is applicable statewide, there are exemptions available which will allow many of the state's smaller gasoline transporting vehicles to avoid having to comply with the certification program. These exemptions are available to vehicles which are operated in conjunction with certain facilities with gasoline throughputs below specified maximum amounts. The smaller tank trucks often deal only with such facilities.

Exempted from the requirments of the regulation are any tank trucks that: (1) receive gasoline only from loading racks which do not have a vapor balance or control system; and (2) deliver gasoline only to stationary storage tanks not equipped with a vapor balance or control system. In the 18 urban counties, other sections of the Ohio regulation [3745-21-09(P), (Q), and (R)] require the installation of a vapor balance or control system on gasoline loading racks at all terminals and at bulk plants with an average daily throughput of 4,000 gallons or more. Vapor balance or control systems are also required at gasoline dispensing facilities (mainly retail gasoline stations) with an annual throughput of 240,000 gallons or more. Outside of these 18 urban counties, the requirement for vapor balance or control systems applies only at existing facilities having the potential to emit a total of 100 tons or more of organic compounds per calendar year.

4.2 CHARACTERIZATION OF AFFECTED SOURCES

The number of gasoline carrying tank trucks that are expected to be covered by the truck tank certification program contained in the Ohio RACT regulations was estimated by contacting representatives of refineries, bulk gasoline terminals, bulk gasoline plants, independent trucking companies and OEPA records and files.

From the discussions with industry representatives, it became apparent that the vast majority of tank trucks covered by the regulation will be associated with the operation of gasoline terminals. Typically, a bulk terminal will receive gasoline by pipeline directly from a refinery and will transport it by truck to a bulk plant for distribution or directly to a large account buyer. The tank truck used for this purpose has a capacity of between 8,000 and 9,000 gallons.

A telephone survey of terminal owners and the large trucking companies that perform gasoline hauling for such facilities identified a total of 954 tanks which are expected to require certification. In addition to these, there are smaller companies and independently owned tank trucks that also provide gasoline hauling services which may be covered by the certification regulation. An estimate of the number of these tank trucks was prepared by the OEPA in the course of this project. The number of regulated tank trucks was estimated to be 500.[1] This estimate was confirmed by contacting a representative of the Ohio Petroleum Marketers Association.[2]

Another type of vehicle known as an account truck is commonly associated with the operation of a bulk gasoline plant. A bulk plant normally receives gasoline by tank truck and distributes it to smaller acount buyers by account truck. The average capacity of such a vehicle normally used in Ohio is 2,000 gallons. Many of these vehicles will either qualify for exemptions as discussed in Section 4.1 or will be removed from gasoline service. These vehicles commonly deliver fuel oil and can avoid regulation by switching to this type of service.

Only one company contacted, SOHIO, stated that they would be certifying their account trucks for leak-tightness. Due to an unusual business arrangement, SOHIO has 117 account trucks participating in the certification program.[3]

To complete the inventory of account trucks requiring certification, an estimate of the number of vehicles associated with bulk plants installing vapor balance on their loading racks was made. The compliance deadline for installing vapor collection systems on the loading racks of bulk plants was July 1, 1981. As of this date, the OEPA records show only seven bulk plants not owned by SOHIO as planning this type of system to achieve compliance. Since they are covered by the RACT regulation, they must have an average daily throughput of 4,000 gallons or more. It is assumed that in order to be able economically to install vapor balance systems, these bulk plants must have an average daily throughput quite a bit higher than 4,000 gallons.

In a previous Ohio study concerning RACT regulations[4], bulk plants in Ohio were modeled in two size ranges by throughput, 2,500 and 13,000 gallons per day. It is assumed then, that these seven bulk plants are all represented by the larger model bulk plant. Associated with the large model plant are four account trucks per bulk plant. Using this methodology, 28 account trucks are thus estimated to be covered by RACT regulations. The total inventory of affected tank trucks is then 1,599; 1,454 of the 8,500 gallon average capacity and 145 of the 2,000 gallon average capacity.

4.2.1 Development of Emission Calculation Methodology

In order to reduce VOC emissions during gasoline loading, unloading, and transport, the affected delivery truck tanks must be vapor tight and equipped with a vapor collection system. During unloading, the tank's vapor collection system collects vapors displaced from storage tanks equipped with vapor recovery systems. During tank filling, VOC vapors are either recovered by the loading facility's vapor recovery system or enter the atmosphere. During transport, VOC emissions are dependent upon the leak tightness of the tank and its vapor collection system.

The estimate of VOC emission reduction that will be obtained by the implementation of Ohio's tank certification requirements was obtained by combining estimated reductions during loading and during transit. Since a tank may be loaded at a rack with vapor control and unloaded at a facility without provisions for vapor control, an estimate was made of VOC emissions that takes this into account. No estimate of emission reduction during unloading was made since this is considered part of the service station emissions.

Emissions during loading were taken from the background information document for bulk terminals.[5] It is assumed that loading racks at bulk plants are identical and that therefore emission rates are identical. It is estimated that an average of 30 percent of VOC vapors are lost during loading without a certification program while only 10 percent are lost during loading with a certification program. These figures represent actual measurements and reflect the fact that a truck that passes the certification test is not likely to remain at the prescribed level of leak-tightness for a full year.

Estimated emissions during transport are based on information in a California Air Resources Board (CARB) staff report.[6] The estimates assume a 2-hour round trip for delivery and are presented in Table 4-1.

Finally, the emission factors for emissions during loading were taken from the U.S. EPA compilation of emission factors.[7] This value is the same for top or bottom loading in vapor balance service and is 8 lb VOC per 1000 gallons loaded. The emission rate for submerged loading without vapor balance or control is 5 lb VOC per 1000 gallons transferred. This rate is also assumed to be representative of that occurring when loading a tank using a vapor balance system that had been unloaded without the use of a vapor balance system.

TABLE 4-1

ESTIMATED VOC EMISSIONS FROM GASOLINE TANK TRUCKS

TANK CAPACITY (gallons)	EMISSIONS FROM LOADING		EMISSIONS DURING TRANSIT[a]		TOTAL EMISSIONS	
	WITH CERTIFICATION PROGRAM (lb VOC)	WITHOUT CERTIFICATION PROGRAM (lb VOC)	WITH CERTIFICATION PROGRAM (lb VOC)	WITHOUT CERTIFICATION PROGRAM (lb VOC)	WITH CERTIFICATION PROGRAM (lb VOC)	WITHOUT CERTIFICATION PROGRAM (lb VOC)
Unloading with[b] Vapor Balance						
8,500	6.8	20.4	6.22	7.21	13.02	27.61
2,000	1.6	4.8	1.47	1.70	3.07	6.50
Unloading without Vapor Balance						
8,500	4.3	12.8	5.21	5.83	9.51	18.63
2,000	1.0	3.0	1.23	1.37	2.23	4.37

[a] Assumes a 2-hour round trip.

[b] Vapor balance at the receiving facility.

4.3 POTENTIAL VOC EMISSION REDUCTIONS

It is assumed in this study that any regulated tank truck will be loaded on a loading rack equipped with a vapor balance system. The tank may be unloaded, however, either with or without the use of a vapor balance system. A tank truck returning to the loading rack after unloading using vapor balance will contain a much higher concentration of VOC vapors than one that was unloaded without vapor balance. The VOC emissions and recovery during loading are dependent upon the concentration of VOC vapors in the tank at the time of loading.

Since the routes and delivery practices for individual tank trucks vary widely, emissions and reductions are calculated for a vehicle that delivers only to facilities employing vapor balance and for a vehicle that delivers only to facilities not employing a vapor balance system. This represents the extremes, and all of Ohio's regulated tank trucks should fall between them.

In order to compute the annual emissions and reductions from a tank truck, an estimate of the average number of delivery trips must be made. To obtain this estimate, it is assumed that all gasoline consumed in Ohio passes through a bulk terminal in Ohio equipped with vapor balance on its loading racks, and is delivered via 8500-gallon tank truck from the bulk terminal to bulk plants or elsewhere. Then the total amount of gasoline consumed divided by the capacity of the fleet of tank trucks gives an average number of delivery trips per year per tank truck. The amount of gasoline consumed in Ohio in 1980 was 4.983 billion gallons.[8] Using the previously determined fleet size of 1,454 tank trucks with an average capacity of 8,500 gallons, an average of 403 delivery trips per vehicle per year is calculated. The transportation capacity of the fleet of 2,000 gallon account trucks was not used to estimate the number delivery trips per vehicle per year. It is assumed that only the larger tank trucks are used in the initial distribution of gasoline and the smaller tank trucks are involved in subsequent distribution activities. It is assumed that this average figure of annual number of delivery trips is representative of all gasoline delivery vehicles in Ohio regulated by RACT.

Table 4-1 presents the emissions that are estimated to occur from the gasoline tank trucks in Ohio which are affected by the certification program. Emission figures are developed for the two different tank sizes for the case where the tank is unloaded with and without vapor balance. In Table 4-2, these emission estimates are shown on an annual basis along with the estimates of emissions reduced by the implementation of the certification program.

In order to provide an estimate of the actual emission reduction that will occur in Ohio as a result of the tank truck certification program, assumptions were made concerning the useage of a vapor balance systems when the tank trucks are unloading at the state's network of gasoline dispensing facilities. It is assumed that 95% of the gasoline consumed in the 18 urban counties is unloaded using a vapor balance system while the rest of the gasoline consumed in the state is unloaded without the use of a vapor balance system.

Using figures provided by the Ohio Department of Taxation[9], 64.5 percent of the gasoline consumed in 1979 is estimated as having been consumed in the 18 urban counties. Assuming that this percentage is representative of 1980, then approximately 3.053 billion gallons of gasoline was delivered utilizing vapor balance in 1980.

Using figures shown in the preceding tables and the assumptions just presented, Table 4-3 was developed. This table presents the estimated VOC emission reductions that may be expected in Ohio by implementing the tank truck certification program. The emission reductions for individual tanks will fall in between the two extremes, depending upon the percentage of their deliveries made to facilities without a vapor balance system. In addition, the estimated statewide total reduction is presented.

4.4 COST ANALYSIS AND SUMMARY

The costs of controlling VOC emissions from the affected tank trucks consist of the cost of the certification test and the incremental cost of

TABLE 4-2

ANNUAL ESTIMATED VOC EMISSIONS AND REDUCTIONS PER TANK

TANK CAPACITY (gallons)	EMISSIONS PER TRIP		ANNUAL EMISSIONS[a]		ANNUAL EMISSIONS PREVENTED WITH CERTIFICATION PROGRAM (tons VOC)
	WITH CERTIFICATION PROGRAM (lb VOC)	WITHOUT CERTIFICATION PROGRAM (lb VOC)	WITH CERTIFICATION PROGRAM (tons VOC)	WITHOUT CERTIFICATION PROGRAM (tons VOC)	
Unloading with Vapor Balance[b]					
8,500	13.02	27.61	2.62	5.56	2.94
2,000	3.07	6.50	0.62	1.31	0.69
Unloading without Vapor Balance					
8,500	9.51	18.63	1.92	3.75	1.83
2,000	2.23	4.37	0.45	0.88	0.43

[a] Assumes 403 round trips per year.

[b] Vapor balance equipment at receiving facility.

TABLE 4-3

ESTIMATED TOTAL VOC EMISSION REDUCTIONS (TONS PER YEAR)

TANK CAPACITY (gallons)	ALL TANKS UNLOADED WITH VAPOR BALANCE	ESTIMATED ACTUAL*	ALL TANKS UNLOADED WITHOUT VAPOR BALANCE
8,500[b]	4,275	3,649	2,661
2,000[b]	100	86	62
TOTAL	4,375	3,735	2,723

*This figure represents the estimated reductions based on the projected volume of gasoline unloaded with and without the use of a vapor balance system. The emission reduction is calculated from the following equation:

$$A = ac(64.5\%)(95\%) + bc[1-(64.5\%)(95\%)]$$

where: A = estimated actual emission reduction for each tank size;

a,b = appropriate annual emissions prevented with certification program (tons VOC) from Table 4-2;

c = appropriate number of tank trucks (either 1454 or 145);

64.5% represents gasoline consumed in the 18 urban counties in 1979; and

95% represents the portion of the gasoline consumed in the 18 urban counties in 1979 that is unloaded using a vapor balance system.

maintenance required to keep the tank leak-free. It is expected that implementation of the certification requirement will increase the frequency of maintenance on a tank to the level necessary to pass the annual test, but will not require the implementation of an entirely new program for tank maintenance.

Although for a tank to be covered by the certification rules it must have a vapor balance or control system, the existence of such a system is required by a different part of Ohio's regulations. Therefore, the costs for providing hardware and maintenance for vapor balance or control systems are not presented in this analysis. Similarly, the credit for product recovery due to the operation of vapor recovery systems has been included in the economic analysis of the regulations requiring these systems. The certification requirement acts as insurance that the credit will be available. Also, the product will normally be recovered by the bulk plant or terminal owner, and this is not necessarily the owner of the tank truck. Therefore, product recovery credits are not included in this analysis either, although they are presented in Table 4-4. In some cases, the value recovered will go directly to the truck owner (when the truck owner is also the bulk terminal or bulk plant owner and vapor recovery systems are in place). In such cases, the actual cost effectiveness will likely be more favorable to these owners.

The estimated costs are presented below for maintaining a tank in leak tight condition. These costs include labor and materials for performing the required maintenance to reduce leakage to an acceptable level and labor for performing the Ohio certification test.

LABOR (hrs)	LABOR[a] ($)	MATERIALS ($)	TOTAL COST ($)
8	192	50	242

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[a] Labor rate = $24 per hour.

TABLE 4-4

CONTROL COST SUMMARY FOR GASOLINE TANK TRUCKS[a] (DOLLARS PER TON REDUCED)

TANK CAPACITY (gallons)	UNLOADING WITH VAPOR BALANCE	ESTIMATED AVERAGE	UNLOADING WITHOUT VAPOR BALANCE
8,500	82.31	96.43	132.23
2,000	350.90	408.02	565.97
Overall Average[b]	88.45	103.60	142.11
Value of Product[c] Recovered	1,402	1,197	872

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[a] Based upon an annual cost per tank of $242 (total annual cost: $386,958), 1454 large capacity tanks, 145 small capacity tanks, and emission reductions from Table 4-3.

[b] Based upon all 1599 tank trucks.

[c] Based upon a 90% recovery of vapors and a value of $0.178 per pound. Units are thousands of dollars.

These costs are similar to those found necessary in the state of California[10] where a similar certification test requirement has been in place for several years. The labor hours indicated have been increased from the four hours deemed necessary in California because conversations with firms in Ohio performing certification tests have indicated that eight hours is the average time required. This may be due to the fact that the Ohio firms have less experience than California firms in performing the test and maintenance procedures. Another reason for the difference may be that tank truck configurations differ between the two states. The costs presented are an average and are independent of tank capacity.

The same report[10] notes that the effort required to bring a tank to within specified limits of leak tightness can be greater than the effort required to maintain this level of leak tightness. This would happen if a large number of potential leak sources were found to be leaking at the first certification test, since not every leak will reappear at every succeeding vapor tightness test.

The certification test may be performed using equipment normally found at the maintenance facilities of a terminal or bulk plant that owns and maintains its own trucks. The maintenance facility may need to purchase a manometer (approximately $50) to perform the test. For those truck owners without maintenance facilities, the test and maintenance can be performed by an independent tank truck maintenance facility set up to conduct the test for a fee. One entrepreneur was found in Ohio who plans to carry the testing and maintenance equipment in trucks and perform the test wherever the truck owner desires.

The estimated cost effectiveness of implementing Ohio's tank truck certification program is presented in Table 4-4. The value of the recovered product is also shown in this table. This value is based upon an assumed 90 percent recovery of vapors and the average wholesale price of gasoline in Cincinnati at the end of 1980.[8]

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5.0 SYNTHESIZED PHARMACEUTICAL MANUFACTURING

5.1 Introduction

The pharmaceutical manufacturing industry encompasses the manufacture, purification, and packaging of medicinal chemical materials. Production activities of this industry can be grouped into the following categories:

Chemical synthesis - The manufacture of pharmaceutical products by chemical synthesis.

Fermentation - The production and separation of medicinal chemicals such as antibiotics and vitamins from microorganisms.

Extraction - The manufacture of botanical and biological products by the extraction of organic chemicals from vegetative materials or animal tissues.

Formulation and packaging - The formulation of bulk pharmaceuticals into various dosage forms such as tablets, capsules, injectable solutions, ointments, etc., that can be taken by the patient immediately and in accurate amount.

The Ohio EPA regulation on the control of VOC emissions from synthesized pharmaceutical manufacturing covers only one of the production activities indicated above--chemical synthesis.[1] Other production activities (fermentation, extraction, and formulation and packaging) are not affected by this regulation. Therefore, any further reference to synthesized pharmaceutical manufacturing in this analysis will mean essentially the chemical synthesis part of synthesized pharmaceutical manufacturing.

Production of a chemically synthesized pharmaceutical product mainly consists of one or more chemical reactions followed by a series of purifying operations. Production lines may contain reactors, filters, centrifuges, stills, dryers, process tanks, and crystallizers piped together in a specific arrangement. One or several pieces of this process equipment can be used in a plant, depending upon its size. Figure 5-1 gives the flow diagram for a typical batch synthesis operation in a synthesized pharmaceutical manufacturing plant. Solid reactants and solvents are charged to a batch reactor, which is usually equipped with a condenser. However, some volatile compounds may still be produced as a product or by-product. Any remaining unreacted VOC (solvents) is distilled off. When the reaction and solvent removal are complete, the product is transferred to a holding tank, in which it undergoes three to four washes of either water or solvent to remove any remaining reactants and by-products. The wash solvent may also be evaporated from the reaction product. The crude product may then be dissolved in another solvent and transferred to a crystallizer for purification. After crystallization, the solid material is centrifuged from the remaining solvent. In the centrifuge, the product cake may be washed several times with water or solvent. Tray, rotary, or fluid-bed dryers may then be used for final product finishing.

Each operation of the chemical synthesis process may be a source of VOC emissions. Because of the wide variation in the operations, manufacturing equipment and the size of operation, typical emission rates cannot be established. But the Control Technique Guideline (CTG) document published by the U.S. EPA[3] gives the following equipment types as the major sources of VOC emissions: (a) dryers, (b) reactors, (c) distillation units, (d) storage and transfer, (e) filters, (f) extractors, (g) centrifuges, and (h) crystallizers.

The Ohio EPA regulation on the control of VOC emissions from synthesized pharmaceutical manufacturing specifies controls for all the major sources of VOC emissions. It requires that the discharge of VOC emissions into the ambient air from any reactor, distillation operation, crystallizer, centrifuge or vacuum dryer should be controlled to a concentration of fifty thousand parts or below by using a surface condenser or any other equally effective control device. VOC emissions

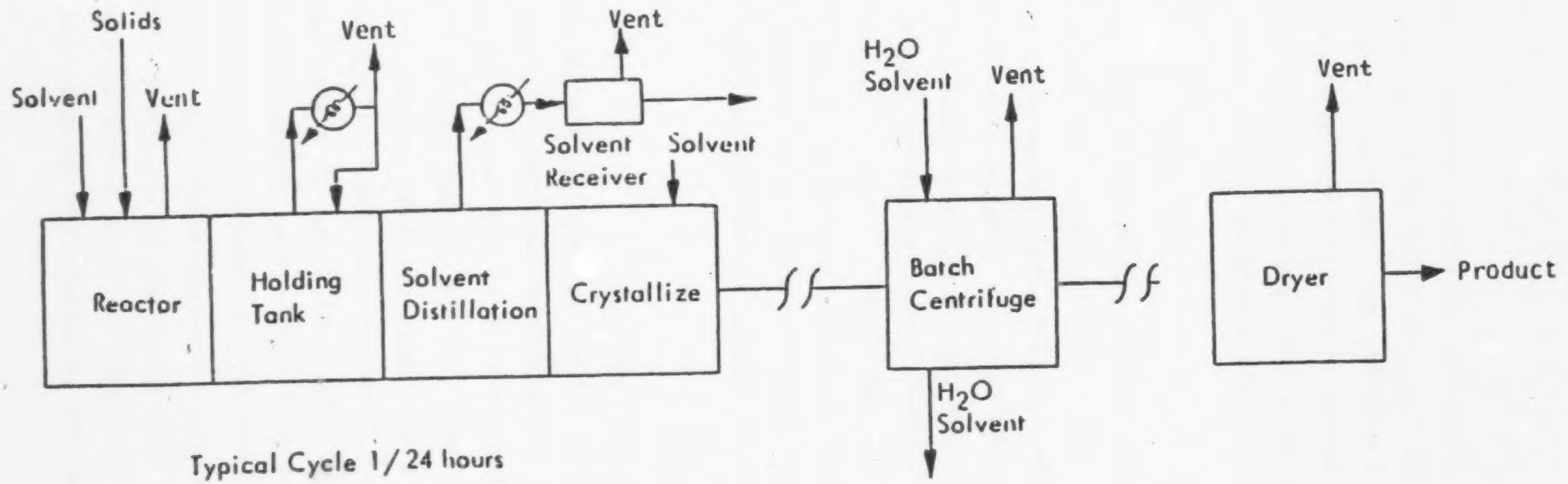
Solids
Solvent
Vent
Vent
Vent
Reactor
Holding Tank
Solvent Distillation
Solvent Receiver
Solvent
Crystallize
H2O Solvent
Vent
Batch Centrifuge
H2O Solvent
Vent
Dryer
Product
Typical Cycle 1/24 hours

FIGURE 5-1   TYPICAL SYNTHETIC ORGANIC MEDICINAL CHEMICAL PROCESS

SOURCE: Reference 2

from any air dryer or a production equipment exhaust system is not to exceed 33 pounds in any one day, unless the emissions have been reduced by at least 90 percent. Similarly, any centrifuge, rotary vacuum filter, or any other filter having an exposed VOC liquid surface should be enclosed if the VOC liquid has a vapor pressure greater than 0.5 psia at 68°F. Finally, any leak of volatile organic liquid should be repaired as soon as possible.

With regard to storage tanks holding VOC liquids with vapor pressure greater than 1.5 psia at 68°F, the regulation requires the use of a conservation vent or any other equally effective device. For the transfer of VOC liquids with vapor pressure greater than 4.1 psia at 68°F from storage tanks with storage capacity greater than 2,000 gallons, a vapor balance or a vapor control system should be used to control at least 90 percent of the VOC emissions. Finally, a cover should be provided for all in-process storage tanks which contain an organic compound liquid. This cover should be kept closed except when production sampling, maintenance, or inspection procedures require access to the tank.

5.2 Inventory of Affected Facilities

The number of facilities affected by the regulation were identified by reviewing the list of Ohio pharmaceutical manufacturers provided by the Ohio EPA and the information given in an EPA report[2] on the operating synthetic pharmaceutical plants in the United States. This review resulted in a list of 16 plants that could be potentially engaged in pharmaceutical manufacturing. However, personal contact with each of these plants indicated that only 2 of these 16 plants were actually involved in the manufacturing of synthesized pharmaceutical products; the other plants were engaged mainly in formulation and packaging operations, which are not covered under the regulation. The inventory data on the two affected plants in Ohio are given in Table 5-1. This information was collected during the visits to these plants by ETA engineers. As the table indicates, total VOC emissions from uncontrolled sources in

TABLE 5-1. OPERATING AND EMISSION DATA FOR AFFECTED SYNTHESIZED PHARMACEUTICAL MANUFACTURING PLANTS IN OHIO

Plant	Uncontrolled Source	Number of Units	Rated Capacity	Hours of Operation (hr/yr)	Total VOC Emissions (tons/yr)
1	Vacuum jets connected to receivers	2	1,700 lbs	4,800	9.7
	Reactors	2	750 lbs	4,800	11.0
2	Reactors	2	20-300 gals	3,000	0.07
	Centrifuge	2	50-100 gals	50	0.13
	Vacuum Dryer	2	132 lbs	1,600	0.09
	Filters (with exposed organic liquid surfaces)	8	5 gals	200	0.11
Total					21.1

these plants are 21.1 tons/year. Most of the emissions are, however, from one plant (20.7 tons/yr). The contribution from the other plant is 0.4 tons/yr.

5.3 Alternative VOC Control Measures

Control techniques that can potentially be used to control VOC emissions from sources at synthesized pharmaceutical manufacturing plants include condensers, scrubbers, carbon adsorption systems, incinerators, or a combination of controls. The following paragraphs briefly describe these controls.

5.3.1 Condensers

Condensers are widely used to recover solvents from reactors, distillation units, extractors, separators, and dryers. Surface condensers are the most prevalent form of control for reactor emissions. In this type of condenser, heat is transferred across a tube wall that separates the vapor and coolant. The coolant is not contaminated with the condensed VOC and, therefore, it may be directly reused. The type of coolant depends on the degree of cooling required and is usually either water or brine. The use of a brine-cooled condenser can usually provide a reduction of approximately 90 percent in VOC emissions.[3]

Condensers are an attractive control option, if the solvent vapor concentration is high. However, when the gas stream is dilute or far from saturation, considerable cooling is required to condense the VOC. In such cases, condensers may not be a cost-effective option.

5.3.2 Scrubbers

Scrubbers can be applied to reduce emissions from reactors, distillation equipment, centrifuges, filters, crystallizers and dryers. These are designed to provide intimate contact between the scrubbing liquid and the gaseous pollutant, which promotes mass transfer between the phases. The liquid absorbs the gas because of the preferential solubility of the gas or gases in the liquid.

Scrubbers can be of the venturi, packed tower, plate or tray tower, and spray tower types. The VOC concentration in a scrubber exhaust is related to the equilibrium partial pressure of the pollutant(s) in the scrubbing medium. For a given unit, overall scrubbing efficiencies are influenced by intimacy of contact between gas and liquid, operating temperature, concentration of the pollutant in the liquid scrubbing medium, and gas and liquid flow rates.

5.3.3 Carbon Adsorbers

Carbon adsorption has been found effective in controlling VOC emissions because many organics are easily adsorbed onto activated carbon. This control technique is particularly effective in controlling gas streams with low VOC concentrations.

The efficiency of adsorption (or removal) on a carbon bed depends on the type of activated carbon used, the VOC characteristics, the VOC concentration, and the temperature, pressure and humidity of the system. Although the overall VOC removal efficiency depends on the system design, units can be designed and operated at removal efficiencies well over 90 percent.[2]

5.3.4 Incinerators

Both thermal and catalytic incinerators can be used to control VOC emissions by oxidizing these to form carbon dioxide and water. However, incinerators are not widely used to control VOC emissions from synthesized dry production, mainly because of high operating costs, variability of waste gases that would be directed to an incinerator, and the intermittent (batch) type of operations used. Fluctuating flows and VOC concentrations may hamper efficient operation.

5.3.5 Applicability of Alternative VOC Emission Control Techniques to Affected Plants

Applicability of alternative control measures to uncontrolled sources in the affected plants was determined in consultation with the affected plants. VOC emissions from a vacuum jet (connected to receivers) in one of the affected plants would be controlled by replacing the present vacuum jet by a new wet ring vacuum pump. VOC emissions from the two uncontrolled reactors in this plant would be controlled by installing a pipe condenser. The planned control strategy for the other plant is to duct VOC emissions from all the uncontrolled affected sources to a single carbon adsorber. The anticipated VOC emission reductions based on the application of the above discussed control techniques are presented in Table 5-2.

5.4 Cost Analysis

Estimation of the control costs to comply with the regulation on synthesized pharmaceutical manufacturing was based on the cost data provided by the affected plants. The annualized costs were derived by adding fixed capital charges to the annual operating and maintenance costs. Fixed capital charges include a capital recovery factor of 14.7 percent (15 year equipment life, 12 percent interest rate) for depreciation and interest charges and a factor for insurance taxes and administrative overheads (4 percent of the installed capital costs). The capital and annualized costs of compliance are presented in Table 5-3. The total capital costs are estimated to be approximately $84,000. The corresponding annualized costs are about $28,000. The overall cost-effectiveness of control is $1,403 per ton of reduction in VOC emissions. As is evident from the table, the cost-effectiveness value for one of the affected plants is extremely high ($55,500/ton of reduction) because of the low anticipated reduction in VOC emissions. The cost-effectiveness of control for the other affected plant is $305 per ton of reduction in emissions.

TABLE 5-2. ESTIMATES OF EMISSION REDUCTIONS FROM AFFECTED PHARMACEUTICAL PLANTS IN OHIO

Plant	Uncontrolled Source	Uncontrolled VOC Emissions (tons/yr)	Anticipated Control Technique	Control Efficiency (%)	Potential VOC Emission Reductions (tons/yr)
1	Vacuum jet connected to receivers	9.7	Replacement of present vacuum jet by a new wet ring vacuum pump	95	9.2
	Reactors	11.0	Pipe condenser	95	10.5
2	Reactors Centrifuges Vacuum Dryer Filters	0.4	Carbon adsorber	95	0.4
		21.1			20.1

TABLE 5-3. CONTROL COST ESTIMATES FOR AFFECTED SYNTHESIZED PHARMACEUTICAL MANUFACTURING PLANTS IN OHIO

Plant	Uncontrolled Source	Control Technique	Control Costs (x 10^3 $)		VOC Emission Reduction (tons/yr)	Cost-Effectiveness ($/ton)
			Capital	Annualized[a]		
1	Vacuum Jet	Replacement of present vacuum jet by a new wet ring vacuum pump	17.0	4.4	9.2	478
	Reactors	Pipe Condensers	1.6	1.6	10.5	152
2	Reactors Centrifuges Vacuum Dryer Filters	Carbon Adsorber	65.0	22.2	0.4	55,500
			83.6	28.2	20.1	1,403

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[a] Annualized costs include the annual operating and maintenance costs and fixed capital charges for depreciation, interest, insurance, taxes and administrative overheads.

5.5 References

1. Personal communication with Mr. Bill Juris of Ohio EPA, October 1981.

2. PEDCo Environmental, Enforceability Aspects of RACT for the Chemical Synthesis Pharmaceutical Industry Preliminary Draft, prepared for U.S. Environmental Protection Agency, Washington, D.C., October 1980.

3. Control of Volatile Organic Emissions from Manufacture of Synthesized Pharmaceutical Products, EPA-450/2-78-029, December 1978.

6.0 RUBBER TIRE MANUFACTURING

6.1 Introduction

Rubber tire manufacturing consists of the production of component parts, their assembly into a raw "green" tire, and the curing and finishing required to yield a complete tire. Several types of rubber tires are mass produced. These include agricultural vehicle tires, airplane tires, industrial vehicle tires, mobile home tires, truck tires, and automobile tires.

A generalized tire manufacturing process consists of four steps: (a) preparation and compounding of raw materials, (b) transformation of the raw materials into tire components, (c) tire component assembly, and (d) molding. Thes steps are shown in more detail in Figure 6-1.

The preparation and compounding of raw material involves combining raw crumb rubber with a variety of fillers, extenders, accelerators, antioxidants, carbon black, and oil in internal mixing devices. After mixing, the rubber is transferred to roll mills and formed into sheets. The sheeted rubber is then fed manually to a warmup roller mill where it is made more flexible for further processing. From the warmup mill, the heated rubber passes to a strip-feed mill for final mixing.

After preparation and compounding, the rubber stock is transformed into components from which the tire is built--tire tread and sidewalls, tire cords, tire belts, and tire beads. These are constructed by using rubber stock and other raw materials, including cord and fabric. A detailed description of their formation process is given in two U.S. EPA documents.[1,2]

The tire components are assembled either by conventional tire building technique or by emerging technologies such as the Orbitread Process or Rotomolding. In the conventional tire building technique, the tires are

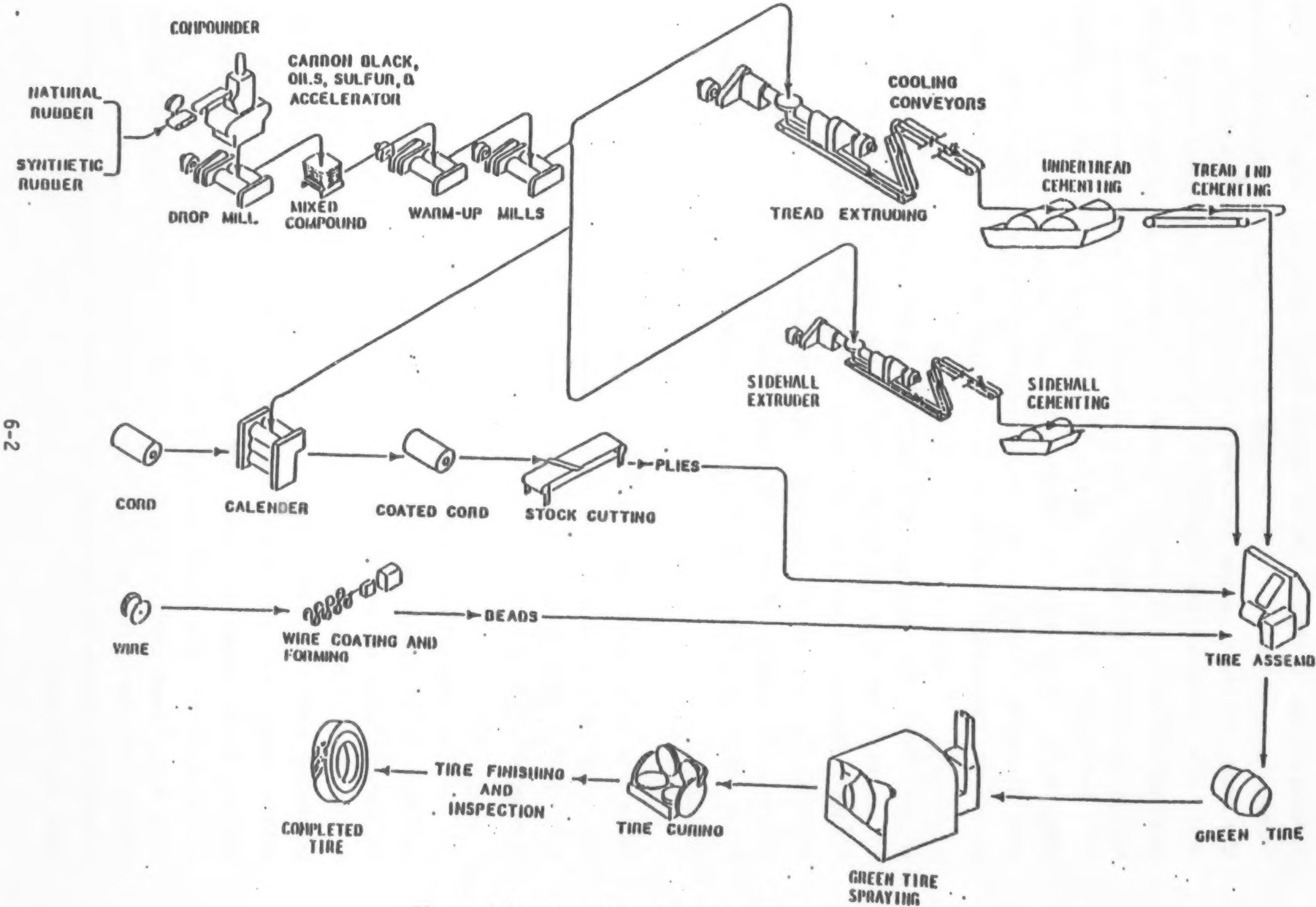
COMPOUNDER
CARBON BLACK, OILS, SULFUR, & ACCELERATOR
NATURAL RUBBER
SYNTHETIC RUBBER
DROP MILL
MIXED COMPOUND
WARM-UP MILLS
TREAD EXTRUDING
COOLING CONVEYORS
UNDERTREAD CEMENTING
TREAD END CEMENTING
SIDEWALL EXTRUDER
SIDEWALL CEMENTING
CORD
CALENDER
COATED CORD
STOCK CUTTING
PLIES
WIRE
WIRE COATING AND FORMING
BEADS
TIRE ASSEMBLY
GREEN TIRE
GREEN TIRE SPRAYING
TIRE CURING
TIRE FINISHING AND INSPECTION
COMPLETED TIRE

Figure 6-1. Tire Manufacturing Flow Diagram

fabricated as cylinders on a collapsible, rotating drum. First the inner lines, which make the finished tire airtight, are wrapped around the drum, followed by the required layers of rubber impregnated fabric. Next, the edges of the fabric and inner lines are wrapped around the bead assemblies. This step is followed by a manual or automatic rolling operation wherein pressure is applied from the tread centerline out to the beads in order to expel air trapped between the assembled components. Belts made of fabric, steel, or glass fiber are then laid onto the cord. Finally, the tread and sidewalls are wrapped around the assembled components and stitched to form an uncured "green" tire.

In the final step (before molding), the green tire is sprayed on the inside with band-ply lubricants and on the outside with mold release agents. Band-ply lubricants allow air to be removed from the inside of the tire as the molding/curing bladder expands. Mold release agents prevent the outside of the tire from sticking to the mold after curing. After this spraying, the tires are molded and cured in automatic presses.

Table 1-1 lists rubber tire manufacturing operations that are sources of VOC. The Table also gives the type of material emitted and the relative contribution of various sources to the overall VOC emissions at a rubber tire manufacturing plant.

The Ohio EPA regulation [Rule 3745-21-09(X)] to control volatile organic compound (VOC) emissions from rubber tire manufacturing exempts the following types of operations: (a) any operation with a maximum VOC discharge of 100 pounds per day or less into the ambient air, (b) any tread-end cementing operation in which the cement is manually applied with a brush, (c) any green tire spraying operation in which the VOC content of the material sprayed is a maximum daily weighted average of six percent or less by weight for material sprayed on the inside of a tire and eleven percent or less by weight for material sprayed on the outside of the tire, and (d) the manufacture of tires with a bead diameter in excess of 20 inches and a cross-sectional dimension greater than 12.8 inches.

TABLE 6-1. TIRE MANUFACTURING VOLATILE ORGANIC COMPOUNDS SOURCES AND EMISSIONS

Operation	Source	Material Emitted	Percent of Total VOC Emissions[a]
Green Tire Spraying	Spray	Solvent	44.8
(inside)			(17.1)
(outside)			(27.7)
Undertread Cementing	Cement	Solvent	25.0
Tire Building	Solvent	Solvent	11.9
Sidewall Cementing	Cement	Solvent	6.1
Tread End Cementing	Cement	Solvent	5.4
Bead Dipping	Cement	Solvent	3.0
Finishing	Ink, Paint, Spray	Solvent	2.1
Curing	Tire	Rubber Volatiles	0.7
Compounding	Rubber Batch	Rubber Volatiles	0.4
Milling	Rubber Stock	Rubber Volatiles	0.2
Extrusion	Rubber Stock	Rubber Volatiles	0.2
Calendering	Rubber Stock	Rubber Volatiles	0.2
Latex Dipping	Latex	Solvent	-

[a] Excluding latex dipping operation.

Source: Reference 2.

The regulation requires that VOC emissions from each undertread cementing, tread-end cementing, and bead dipping operation be controlled by at least 76.5 percent (85 percent capture and 90 percent control efficiency). Similarly, VOC emissions from a green tire spraying system should be controlled by at least 81 percent by weight based on at least 90 percent capture efficiency and at least 90 percent control efficiency.

6.2 Inventory of Affected Sources

The affected rubber tire manufacturing plants were identified through inventory information provided by the Ohio EPA, information provided in a U.S. EPA report,[2] and personal communication with rubber tire manufacturing plants in Ohio. A preliminary list of nine potentially affected rubber tire manufacturing plants was prepared by reviewing the information provided by the Ohio EPA and the U.S. EPA document. These plants were (1) Firestone Tire and Rubber, Akron; (2) Dayton Tire and Rubber, Barberton; (3) Goodyear Tire and Rubber, Akron; (4) Dayton Tire and Rubber, Dayton; (5) General Tire and Rubber Company, Bryan; (6) Cooper Tire and Rubber Company, Findlay; (7) Denman Rubber Manufacturing Company, Warren; (8) General Tire and Rubber Company, Akron; and (9) B. F. Goodrich Company, Akron. The list of potentially affected plants was then verified by contacting the individual plants.

This plant investigation revealed that Firestone originally had two tire manufacturing facilities in Akron. One of these facilities has been closed and demolished, however, and the other performs only mixing and compounding operations.[3] This plant is therefore not affected by the regulation on rubber tire manufacturing. Similarly, Dayton Tire and Rubber had two facilities in Ohio manufacturing tires--one in Barberton and the other in Akron, but both of these facilities have been shut down.[4] The General plant in Bryan produces only large off-the-road tires (heavy construction tires, for example) and therefore is not affected by the regulation based on size criterion.[5] Similarly, the Goodyear plant in Akron manufactures only race car tires and is not affected by the regulation.[6]

The Ohio EPA adopted regulation therefore affects only four rubber tire manufacturing plants in Ohio, two plants in Summit County, and one each in Hancock and Trumbull counties. The location and the tire production capacities for these plants are presented in Table 6-2. The production data were taken from the publication Modern Tire Dealer[7] and are for January 1981.

As Table 6-2 shows, the individual plant tire production capacities range from 700 to 14,500 tires per day (tpd), with an average rate of 7,025 tpd. Two of the plants manufacture automobile tires, and their production rates range from 200 to 10,000 tpd. The other tires produced are principally truck tires, although one plant manufactures airplane tires. The production rates for all other tires range from 700 to 8,500 tpd, the average being 4,475 tires per day per plant.

The affected plants were contacted to procure plant-specific data on their sources of VOC emissions, present VOC emission levels, exhaust gas flow rates, and VOC concentration in the exhaust gases. Other plant-specific data obtained included hours of operation, present emission controls, and additional controls required to comply with the adopted regulation.[8-11] Plant contacts indicated that only two of the four affected plants use undertread cementing and bead dipping operations. One of these plants reports zero VOC emissions from both processes due to mechanical design. All of the affected plants perform the tread-end cementing operation manually, so this operation is exempt from the regulation. Green tire spraying is also done at all the affected plants, using a water-base release agent on one side of a tire and a solvent-base release agent on the other side. Ultimately, all four plants will be switched to water-base release agents for both sides--inside and out.[8-11] Table 6-3 presents the total number of operations in the affected plants that require additional controls for compliance with the adopted regulation. The table also presents the uncontrolled VOC emissions from these operations, which were calculated based on actual solvent usage for various operations in the affected plants. A total of 17 operations in the affected tire manufacturing plants emit-

TABLE 6-2. AFFECTED PLANTS AND THEIR TIRE PRODUCTION CAPACITY[a]

Facility	City	County	Passenger Tires Per Day	Other[b] Tires Per Day	Total Tires Per Day
Cooper Tire & Rubber Co.	Findlay	Hancock	10,000	4,500	14,500
Denman Rubber Manufacturing Company	Warren	Trumbull	200	4,200	4,400
General Tire & Rubber Co.	Akron	Summit	-	8,500	8,500
B.F. Goodrich Company	Akron	Summit	-	700	700

[a] Tire production capacities based on information in Reference 7.

[b] Other tires include truck tires and airplane tires.

TABLE 6-3. OPERATIONS IN AFFECTED TIRE MANUFACTURING PLANTS REQUIRING ADDITIONAL CONTROLS

Operation	Number of Operations Requiring Control	VOC Emissions[b] (tons/year)
Undertread Cementers	2	66
Bead Dippers	1	30
Green Tire Spraying	14	766
Total[a]	17	862

[a] Represents total number of operations in 4 affected plants that need additional controls to comply with the regulation.

[b] Estimated based on emission data provided by the affected plants.

ting 862 tons per year of VOC would require additional controls to comply with the Ohio EPA adopted regulation. It may be noted that all the undertread cementing and bead dipping operations requiring controls are at one rubber manufacturing plant.

6.3 Alternative VOC Control Measures

Alternative VOC control measures available to the tire manufacturing industry include add-on controls (incineration and vapor adsorption) and the use of rubber cements and solvents with low VOC contents. The applicability of these control measures to various affected tire manufacturing operations is presented in Table 6-4. The control options listed in the table are briefly described in the following subsections.

6.3.1 Incineration

Both thermal incinerators and catalytic incinerators can be used for the control of VOC emissions in the tire manufacturing industry. The efficiency of an incinerator depends on the types of VOCs to be incinerated and on such factors as temperature, residence time, mixing, inlet concentration, and flow patterns. Incineration temperatures for a thermal incinerator range from 880°F to 1800°F, and those for catalytic incinerators range from 400°F to 1200°F. The control efficiency is between 81 and 96 percent for a catalytic incinerator and can be above 98 percent for a thermal incinerator.[2] Usually, catalytic incinerators consume 40 to 60 percent less fuel than thermal incinerators, since the catalyst requires lower temperatures to bring the vapor and fuel mixture to its ignition point.

One of the main disadvantages associated with the use of incinerators is the consumption of fuel when no VOCs are present. Incinerators require continuous fuel burning, even though VOCs may not always be present in the exhaust stream. For example, when a source such as an undertread cementer is not operation, reduced solvent evaporation results. Therefore, with an incinerator as the control option, additional fuel is needed during periods of low solvent evaporation as gas streams with minimal VOC content continue to be incinerated.

TABLE 6-4. CONTROL TECHNOLOGY OPTIONS FOR RELEVANT TIRE MANUFACTURING OPERATIONS

Operation	Capture Efficiency (wt%)	Control Efficiency (wt%)	Overall Efficiency (wt%)	Control Technique Options
Undertread Cementing	85	90	76.5	Carbon Adsorption Thermal Incineration Catalytic Incineration
Bead Dipping	85	90	76.5	Carbon Adsorption Thermal Incineration Catalytic Incineration
Green Tire Spraying	90	90	81.0	Carbon Adsorption Thermal Incineration Catalytic Incineration
	Process Modification			Low Solvent Spray[a]

[a] VOC content: Inside spray, 6% or less
Outside spray, 11% or less

6.3.2 Carbon Adsorption

Carbon adsorption, an alternative to incineration, reduces VOC emissions by collecting organic vapors on the external surface of activated carbon adsorbent. The control efficiencies are reported to be around 95 percent,[2] although humidity can adversely affect carbon adsorption collection efficiency when the moisture content of the exhaust stream exceeds 50 percent. Carbon adsorbers are capable of effectively treating low organic vapor concentrations, and typical design flow rates range from less than 100 scfm to 80,000 scfm,* which covers exhaust flow rates from the tire industry (210 scfm to 62,000 scfm/unit).[2]

Carbon adsorbers have an advantage over incinerators, since they can remove low VOC concentrations (less than 100 ppm) from exhaust streams, even in the presence of water. However, several disadvantages are also associated with the use of carbon adsorbers. Any particulate matter in the exhaust stream may plug the carbon beds, lowering their VOC collection efficiencies. Also, the required depth of a carbon bed increases with the number of compounds in the exhaust stream. Further, VOCs are adsorbed in an inverse relation to compound volatilities, with highly volatile compounds adsorbed first. As a result, the composition of reclaimed materials may differ greatly from the virgin material, possibly precluding its reuse in a tire manufacturing operation.

6.3.3 Application of Low VOC Content Compounds

One alternative to the use of add-on control devices for the reduction of VOC emissions in tire manufacturing operations is the use of rubber cements and solvents with low VOC content. At the present time, however, green tire spraying is the only operation in the tire manufacturing industry for which low VOC materials are well developed, i.e., water-base solvents for inside and outside green tire spraying.

6.3.4 Application of VOC Control Technology to Tire Manufacturing Operations

As shown in the foregoing discussion, the tire manufacturing operations in Ohio that require additional control to comply with Ohio EPA regulation include some undercementing and bead dipping operations, and several green tire spraying operations (see Table 6-3). All the tread-end cementing operations are done manually and are thus exempted from the control requirements of the regulation. The selection of the most appropriate control technologies for various affected operations was based on engineering judgement and discussions with the affected facilities.

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*Standard cubic feet per minute.

For undertread cementing and bead dipping operations, an add-on control device is expected to be the most appropriate, since low VOC materials for these operations are not yet available. Based on preliminary discussions with the affected plant, a carbon adsorber was assumed to be the preferred add-on control device. For green tire spraying operations, both add-on controls and low solvent materials can be used to reduce VOC emissions. All the affected plants favored the use of water-base (low VOC) release agents as a method for VOC reduction.

The potential VOC emission reductions available from the application of alternative control measures are presented in Table 6-5. The control efficiencies of various control options were derived from the provisions of the regulation. For example, the overall control efficiency of an add-on control device was assumed to be 81 percent based on 90 percent capture and 90 percent control, as required under the regulation. The control efficiency for the application of water-base release agents in green tire spraying was based on (1) the solvent contents specified in the regulation and (2) the assumption that the present solvent-based release agent is 100 percent VOC. Based on the use of water-base release agents in green tire spraying and add-on control devices for other operations, the potential VOC emission reductions from the tire manufacturing industry in Ohio is estimated to be approximately 775 tons/year. If add-on control devices are used for all the affected operations, the potential VOC emission reduction would be approximately 694 tons/year, as shown in Table 6-5.

TABLE 6-5. ESTIMATE OF POTENTIAL VOC EMISSION REDUCTION FROM TIRE MANUFACTURING INDUSTRY IN OHIO

Tire Building Operation	Uncontrolled VOC Emissions (tons/yr)	Control Technique	Reduction[a]		Controlled Emission Level (t/yr)
			%	t/yr	
Green Tire Spraying	766	Control device[b]	81.0	620	146
		Low solvent agent	91.5[c]	701	65
Undertread Cementing	66	Control device[b]	76.5	51	15
Bead Dipping	30	Control device[b]	76.5	23	7
Total A	862	Control devices	-	694	168
Total B	862	Low-solvent & control devices	-	775	87

[a] Percent reduction derived from the adopted regulation.

[b] Control device is a carbon adsorber, thermal incinerator, or a catalytic incinerator.

[c] This control efficiency based on the average non-solvent concentration between inside and outside sprays.

$$\frac{(1-.06) + (1-.11)}{2} = .915$$

6.4 Cost Analysis

The costs of controlling VOC emissions from the affected tire manufacturing operations were estimated by reviewing the operational data for the individual operations. Since all the affected undertread cementing and bead dipping operations were in one tire manufacturing plant, it was assumed that the emissions from all the sources would be combined and ducted to one control device. Based on discussions with this affected plant, the exhaust air flow rate for all the affected undertread cementing and bead dipping operations was estimated to be 36,500 acfm.* Only add-on controls were considered in the compliance cost analysis for undertread cementing and bead dipping operations. This is because low solvent content materials for these applications are not commercially available at the present time.

With regard to green tire spraying operations, all affected facilities are planning on or are in the process of converting their solvent-based spraying booths to water-base sprays. From discussions with one of the affected plants, two sets of costs were estimated for switching to water-base sprays. One set of cost estimates was based on minor equipment changes in existing spray booths to use water-base release agents. The other set of cost estimates was based on the installation of a new, larger oven conveyor system to increase the residence time of the product sprayed with water-base agents. This modification would provide the required additional drying time without slowing down production. The cost estimates provided by two of the affected plants for the two alternative process changes noted above were extrapolated to represent the cost impact on all the affected green tire spraying operations in the industry.

The costs of applying add-on control devices to green tire spraying operations were also estimated so as to reflect the relative cost impacts of applying different control options. To estimate the capital and operating costs of applying add-on controls to green tire spraying operations, the actual exhaust gas flow rates for affected green tire spraying operations were used in coordination with cost data in a U.S. EPA cost manual.[12] Further, it was assumed that a single control device would be used in each of the affected plants. This would mean ducting exhaust gases from all green tire spray booths in each plant by a single control.

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*Actual cubic feet per minute.

Similarly, for undertread cementing and bead dipping operations, the costs of applying various add-on control devices were based on the actual exhaust gases from the affected operations and cost data in the EPA cost manual (Ref. 12). All the costs were updated to June 1981 dollars. Table 6-6 summarizes the capital costs, the annualized costs, and the cost-effectiveness of applying various control measures to affected operations in tire manufacturing facilities. As indicated in the table, the costs of VOC control from one affected bead dipping operation is included in those for undertread cementing. Since all these affected operations are at one facility, they can be assumed to be ducted to one single control device.

Table 6-7 presents an estimate of the total anticipated compliance costs for the tire manufacturing industry in Ohio based on the preferred control technologies for affected operations. Use of a water-based release agent was judged to be the most preferred control measure for green tire spraying. A carbon adsorber was used as the control measure for controlling VOC emissions from undertread cementing and bead dipping. Based on the use of these control technologies, the total compliance captial costs were estimated to be $1,014,000. The corresponding annualized costs were estimated to be $276,000. The overall cost-effectiveness of control was determined to be $356 per ton of reduction in VOC emissions.

TABLE 6-6. COST ESTIMATES OF APPLYING DIFFERENT CONTROL OPTIONS TO AFFECTED TIRE MANUFACTURING OPERATIONS[a]

Operation and Control Options	Number of Affected Operations	Capital Costs (x10³$)	Annualized Costs (x10³$) Capital Charges[b]	Annualized Costs (x10³$) Operational & Maintenance Costs[c]	Annualized Costs (x10³$) Energy Costs[d]	Annualized Costs (x10³$) Total	VOC Emission Reductions (tons/yr)	Cost-Effectiveness ($/ton)
Undertread Cementing[e]	2							
- Thermal Incinerators[f]		350	76	18	150	244	74	3,297
- Catalytic Incinerators[f]		635	138	32	(10)	160	74	2,162
- Carbon Adsorbers[g]		246	53	7	63	109	74	1,473
Bead Dipping	1	h	h	h	h	h	h	h
Green Tire Spraying	14							
- Switch to Water-Base Sprays		135-1,400[i]	29-304[i]	j	j	29-304[i]	701	41-434
- Thermal Incinerators[f]		1,104	240	55	442	737	620	1,189
- Catalytic Incinerators[f]		2,004	435	100	(30)	505	620	814
- Carbon Adsorbers[g]		776	168	123	186	231	620	373

[a] The costs are in June 1981 dollars.

[b] Capital charge factor of 21.7 percent includes 17.7 percent for depreciation and interest (12 percent borrowing rate, 10 years equipment life) and 4 percent for taxes, insurance and administration.

[c] Assumed to be 5 percent of the capital costs.

[d] Natural gas assumed at @ $2.0/mcf.

TABLE 6-6 (continued)

[e] Combined and ducted to a single control device.

[f] 35 percent heat recovery included.

[g] Cost estimate includes fuel credit for recovered solvent. Toluene assumed with credit at $0.94 per gallon. Derived from regional price of No. 2 distillate fuel oil (Bureau of Labor Statistics).

[h] Costs are included in figures for undertread cementers.

[i] The lower value corresponds to minor modification in existing spray booths and upper value is based on the installation of new larger conveyor lines in the ovens.

[j] The incremental O & M and energy costs were assumed to be negligible.

TABLE 6-7. ANTICIPATED COMPLIANCE COSTS FOR THE TIRE MANUFACTURING INDUSTRY IN OHIO

Operation and Anticipated Control Option	Capital Costs ($\times10^3$\$)	Annualized Costs ($\times10^3$\$)	VOC Emission Reductions (tons/yr)	Cost-Effectiveness (\$/ton)
Undertread Cementing				
- Carbon Adsorber	246	109	74	1473
Bead Dipping				
- Carbon Adsorbers	a	a	a	a
Green Tire Spraying				
- Switch to Water-Based Materials	768[b]	167	701	238

[a] Cost included under undertread cementing, since bead dipper and undertread cementing operations are ducted to the same control device.

[b] Based on the average of the cost range presented in Table 6-6.

6.5 References

1. "Control of Volatile Organic Emissions from Manufacture of Pneumatic Rubber Tires," EPA-450/2-78-030, U.S. EPA, Research Triangle Park, North Carolina, December 1978.

2. "Rubber Tire Manufacturing Industry--Background Information for Proposed Standards," Preliminary Draft, U.S. EPA, Research Triangle Park, North Carolina, November, 1980.

3. Personal communication with Robert Walter, Firestone, October 1, 1981.

4. Personal communication with Carl Schaeffer, Dayton Tire & Rubber, October 1, 1981.

5. Dames and Moore, personal communication with Mr. Townhill, General Tire, Akron, Ohio, May 6, 1981.

6. Dames and Moore, personal communication with Mr. Standke, Goodyear, Akron, Ohio, May 1, 1981.

7. Modern Tire Dealer.

8. Personal correspondence with Dave Pinney of Denman Rubber Manufacturing, Company, Warren, Ohio, July 1981.

9. Personal correspondence with Ronald Clark of B. F. Goodrich, Akron, Ohio, July 1981.

10. Personal communication with Bill Zimmerman of Cooper Tire, Findlay, Ohio, July 1981.

11. Personal correspondence with Fred Troppe of General Tire, Inc., Akron, Ohio, August 1981.

12. "Capital and Operating Costs of Selected Air Pollution Control Systems," EPA-450/5-80-002, U.S. EPA, Research Triangle Park, North Carolina, December 1978.

7.0 FLEXOGRAPHIC, PACKAGING ROTOGRAVURE, AND PUBLICATION ROTOGRAVURE PRINTING LINES

7.1 INTRODUCTION

Flexography is a form of letterpress that incorporates an image carrier made of rubber and other elastomeric materials rather than metal plates. The image areas are raised relative to the non-image areas. Ink is applied to the image areas and then transferred directly to the substrate. In rotogravure printing, the image areas are recessed relative to the non-image areas. The image carrier is normally a copper plated cylinder, which may also be chrome plated to enhance wear resistance. The image is in the form of cells or cups mechanically or chemically etched in the cylinder's surface. Magazines, catalogues, and brochures are among the products printed by the publication gravure industry. Packaging items printed by rotogravure or flexography include cartons, corrogated paper board, envelopes, paper and plastic bags, paper and foil labels, and plastic and foil overwraps.

Publication gravure printing is done at large plants, numbering less than fifty nationwide. Packaging gravure and flexographic printing is done by a considerably larger number of firms, ranging in size from large integrated companies with many presslines to small operations with only one or two press lines. In the mid-1970's, there were an estimated 14,000 package gravure and 30,000 flexographic printing lines in the nation.[1]

Gravure and flexography printing both require low viscosity inks that are solvent or water-based. Solvent content in solvent-based inks ranges from about 50 to over 90 percent, while water-based inks have solvent contents of 25 percent or less. Typical solvents include these volatile organic compound (VOC) categories: alcohols, aliphatic napthas, aromatic hydrocarbons, esters, ethers, glycols, and ketones. The inks dry by solvent absorption into the web and/or evaporation. The major sources of VOC emissions from printing operations are the printing units and the ink dryers. The latter hasten solvent evaporation by passing high velocity air over the substrate at temperatures sufficiently low to avoid damaging the substrate.

Ohio's RACT regulation is applicable statewide to facilities having rotogravure and/or flexographic printing lines with total annual VOC emissions in excess of 100 tons. Exempt from the regulation are printing lines which apply vinyl coatings and printing lines used solely to check the quality of image formation of newly engraved or etched cylinders.

7.2 CHARACTERIZATION OF AFFECTED SOURCES

7.2.1 Publication Rotogravure

The three Ohio publication gravure plants in operation as of January 1978 are listed in Table 7-1. The Art Gravure Corporation of Ohio will be the sole plant operating in the state by December 1982. The plant is already equipped with solvent vapor recovery systems, which company management believes are adaquate for compliance with Ohio's RACT regulation.[2]

7.2.2 Packaging Rotogravure

The inventory of packaging gravure plants potentially affected by the RACT regulation is based on three sources of information: emission inventory data compiled by the Ohio EPA; supplementary inquires made to Ohio EPA District Engineers; and the 1980 Ohio Industrial Directory. Firms identified by any of these sources were contacted to obtain information regarding their printing operations. Due to requests that detailed information regarding annual production, product mix, and ink consumption be treated as confidential, survey questions and responses are phrased in somewhat generalized terms. The following questions were asked to determine if a particular plant is affected by the RACT regulation:

TABLE 7-1

PUBLICATION ROTOGRAVURE PLANTS IN OPERATION AS OF JANUARY 1, 1978[3]

NAME	LOCATION	REMARKS
Art Gravure Corporation of Ohio	Cleveland	Equipped with a carbon adsorption system
Dayton Press, Inc.	Dayton	In process of terminating operations
Springfield Gravure Corporation	Springfield	No longer in operation

- Is packaging gravure printing done at the plant?
- Are inks currently used primarily solvent-based or water-based?
- Has estimated annual solvent consumption in packaging gravure operations been at least 100 tons in recent years?
- What solvent vapor emission control equipment is presently installed?
- What measures are being seriously considered or are being taken to reduce solvent vapor emissions to comply with the RACT regulations?

Management personnel at 11 Ohio plants supposedly engaged in packaging gravure printing were contacted. This type of printing is not done at 2 of the 11 plants. The remaining plants affected by the RACT regulation are summarized in Table 7-2. The judgment that a plant is affected is based on one or more of:

- Annual emissions data from the Ohio Emission Inventory Summary (EIS);
- Request for a compliance extension from the Ohio EPA; and
- Plans or a commitment made to increase the use of water-based ink, as a response to the RACT regulation.

From Table 7-2, the preferred compliance strategy at 6 of the 9 plants is the increased use of water-based inks. Solvent vapor recovery systems represent the preferred compliance strategy at two plants. In addition, American Can Company plans to transfer its packaging rotogravure printing operations out of state due, in part, to the RACT regulation.[4]

7.2.3 Flexographic Printing

The inventory of flexographic printing plants affected by the RACT regulation is based on four sources of information: Ohio EIS data; supplementary inquiries made to Ohio EPA District Engineers; the Flexographic Technical Association (FTA); and the 1980 Ohio Industrial Directory. Firms identified from these sources were contacted to

TABLE 7-2

INVENTORY OF OHIO PACKAGING ROTOGRAVURE PRINTING PLANTS AFFECTED BY THE RACT REGULATION[a]

PLANT NAME	LOCATION (CITY)	TOTAL HYDROCARBON EMISSIONS[a] (tons/yr)	MEASURES CONSIDERED OR TAKEN TO REDUCE SOLVENT VAPOR EMISSIONS
American Can Company	Cleveland	372	printing operations being discontinued
Colorpac Inc.	Franklin	776	solvent recovery system
Georgia Pacific Company[b]	Cincinnati	854	increased use of water-based inks
Ludlow Packaging Company[b]	Mount Vernon	951	increased use of water-based inks
Ohio Match	Wadsworth	101	increased use of water-based inks
Olinkraft Inc.	Evandale	436	increased use of water-based inks
Packaging Corporation of America	Rittman	215	increased use of water-based inks
St. Regis Paper	Middletown	1000	increased use of water-based inks
Specialty Paper Company	Dayton	735	solvent recovery system

[a] Based on 1979 Ohio Emission Inventory Summary.

[b] Both packaging gravure and flexographic printing done at this plant. Emissions from all printing operations are presented.

obtain information regarding their printing operations. In contrast to the gravure printing industry, the development of an inventory of flexographic printing plants potentially affected by the RACT regulations is complicated by:

- The inclusion of flexographic printing operations in Standard Industrial Classification (SIC) codes 2641, 2643, 2649, 2751, 2754, 3079, and 3497.[5]
- The use of a number of inks, which may be solvent and/or water-based, at most flexographic printing plants;
- The wide range of flexographic printing plant sizes, in terms of number of presses, number of employees, product quantity, and ink consumption; and
- The use of solvent and/or water-based inks in printing operations, such as letterpress or lithography, conducted at the same premises as is flexographic printing.

Management personnel at 45 Ohio printing plants supposedly having some involvement in flexographic printing were contacted. The following questions were asked to determine if a particular plant is affected by the RACT regulation:

- Is flexographic printing done at the plant?
- Are inks used primarily solvent or water-based?
- Has estimated annual solvent consumption in flexographic printing operations been at least 100 tons in recent years?
- What solvent vapor emission control equipment is presently installed?
- What measures are being seriously considered or are being taken to reduce solvent vapor emissions to comply with the Ohio RACT regulation?

Plants were eliminated from the inventory for one or both of the following reasons:

- Flexographic printing is no longer done at the plant;
- The quantity of VOC emissions from flexographic and rotogravure printing is well under 100 tons per year.

The inventory of plants assumed to be affected by the RACT regulation is presented in Table 7-3. The judgment that these plants are affected is based on one or more of:

- Emission data from the Ohio EIS;
- Request for a compliance extension from the Ohio EPA; and
- Plans or a commitment made to increase the use of water-based ink, as a response to the RACT regulation.

From Table 7-3, the preferred compliance strategy expressed for all the affected plants is the increased use of water-based inks. Diamond International has already submitted for Ohio EPA approval a plan to achieve compliance by sufficiently extensive use of water-based inks.[6] Several companies contacted have requested a compliance extension from the Ohio EPA in order to better determine the degree to which water-based inks can replace solvent-based inks used at their Ohio facilities.

7.3 ALTERNATIVE CONTROL MEASURES

Alternate methods of controlling VOC emissions from gravure and flexographic printing operations are: capture systems with control devices, the use of low solvent (water-based) inks, and high solids inks. The following subsections describe these control strategies and their applicability to the three regulated printing industries.

7.3.1 Capture Systems with Control Devices

A printing plant's VOC emission control system consists of two discrete sections: the capture system which collects solvent vapors in the pressroom, and a control device used to either recover or destroy captured solvent. Carbon adsorbers and fume incinerators are considered proven, high efficiency equipment for controlling solvent vapor emissions from rotogravure and flexographic printing operations.[1]

Ohio RACT II regulations specify a minimum control device efficiency of 90 percent for the three categories of printing operations addressed

TABLE 7-3

INVENTORY OF OHIO FLEXOGRAPHIC PRINTING PLANTS AFFECTED BY THE RACT REGULATION[a]

PLANT NAME	LOCATION (CITY)	TOTAL HYDROCARBON EMISSION[a] (tons/yr)	MEASURES CONSIDERED OR TAKEN TO REDUCE SOLVENT VAPOR EMISSIONS
Champion International[b]	Olmstead Falls	367[d]	increased use of water-based inks
Cloudsley Company	Forest Park	605	increased use of water-based inks
H.S. Crocker Company	Blue Ash	183	increased use of water-based inks
Diamond International	Lockland	412	increased use of water-based inks
Diamond International	Norwood	514	increased use of water-based inks
Georgia Pacific Company[c]	Cincinnati	854	increased use of water-based inks
Jaite Packaging Company[b]	Akron	367[d]	increased use of water-based inks
Ludlow Packaging Company[c]	Mount Vernon	951	increased use of water-based inks
Mead Paper Company[b]	Chillocothe	367[d]	increased use of water-based inks
Zumbiel Company	Norwood	119	increased use of water-based inks

[a] Based on 1979 Ohio Emission Inventory Summary.

[b] Included in inventory due to expressed concern over impact of RACT regulation on printing operations.

[c] Both packaging gravure and flexographic printing done at this plant. Emissions from all printing operations are presented.

[d] Estimated annual emissions equal to the average of the annual emissions from the five facilities at which only flexographic printing is performed.

in the regulations. The regulations require a VOC capture system efficiency of 60 percent for flexographic printing, 70 percent for packaging rotogravure printing, and 75 percent for publication rotogravure printing. Since overall emission reduction efficiency is a function of capture efficiency and control device efficiency, the required overall VOC reductions are approximately 58.5, 63.0, and 72.0 percent for flexographic, packaging rotogravure, and publication rotogravure, respectively. These values do not take into account solvent retained in the printed product.

7.3.1.1 Capture System Efficiency

Most press lines have dryer enclosures and ductwork designed to capture and convey VOC exhaust vapors away from the presses. Capture efficiency is a function of drying temperature, operating speed of the press, and air flow from the dryers. Capture systems at most plants collect only the dryer exhaust. However, dryer exhaust is not the only solvent-laden air that can be collected by a high efficiency capture system. Fugitive vapors from solvent evaporation in the ink fountains, from exposed portions of the printing cylinder, and from exposed portions of the printed web ahead of the dryers can be reduced by enclosing ink fountains and extending the dryer enclosure. However, these areas may still be exposed during press shutdowns for web breaks, cylinder changes, and maintenance. Fugitive solvent vapors will also be emitted from the web during shutdowns. A few plants' vapor capture systems incorporate floor and/or room vents near each press to collect fugitive emissions from the pressroom. Since the final printed product may retain up to seven percent of solvent used in the printing operation, the product remains a source of fugitive VOC even after cutting and folding operations.

7.3.1.2 Carbon Adsorption Systems

Carbon adsorption systems available in the United States may be classified as fixed or fluidized bed systems. In either adsorption process, at least 95 percent of the solvent vapor molecules can be removed from an airstream. Subsequent stripping of solvent molecules from the carbon is called desorption or bed regeneration.

Fixed-bed adsorption systems are more commonly associated with publication gravure operations, since the principal solvent (toluene) can be separated from the water with relative ease, and solvent cost makes recovery and recyling economically desirable. As of 1977, 19 of the nation's 27 publication gravure plants employed fixed bed adsorption systems on at least one press line.[3] As indicated in Table 7-1, the only Ohio publication gravure plant which will remain operational beyond 1982 has carbon adsorption systems.

In contrast to the publication gravure industry, inks typically used in packaging gravure and flexographic printing often contain complex mixtures of solvents which are not equally soluable in water. Nevertheless, there is growing interest in carbon adsorption systems from the packaging gravure industry. A previous national study of the flexible packaging industry indicated that 4 of the 154 plants surveyed were equipped with fixed bed adsorption systems.[7] As indicated in Table 7-2, management at two Ohio package gravure plants presently consider solvent recovery systems as their preferred RACT compliance strategy.

A flow diagram of a fixed bed adsorption system is presented as Figure 7-1. During the adsorption cycle, solvent concentration in the adsorber unit's exhaust remains relatively constant until breakthrough occurs. After this bed saturation level is reached, the outlet solvent concentration increases rapidly. A hydrocarbon analyzer can be used to monitor solvent concentration in the adsorber unit exhaust. The solvent-laden airstream can then be re-routed to another adsorber unit, while the saturated bed is desorbed. Regeneration is usually accomplished by flushing with low pressure stream. The stream and solvent vapor must then be condensed and separated.

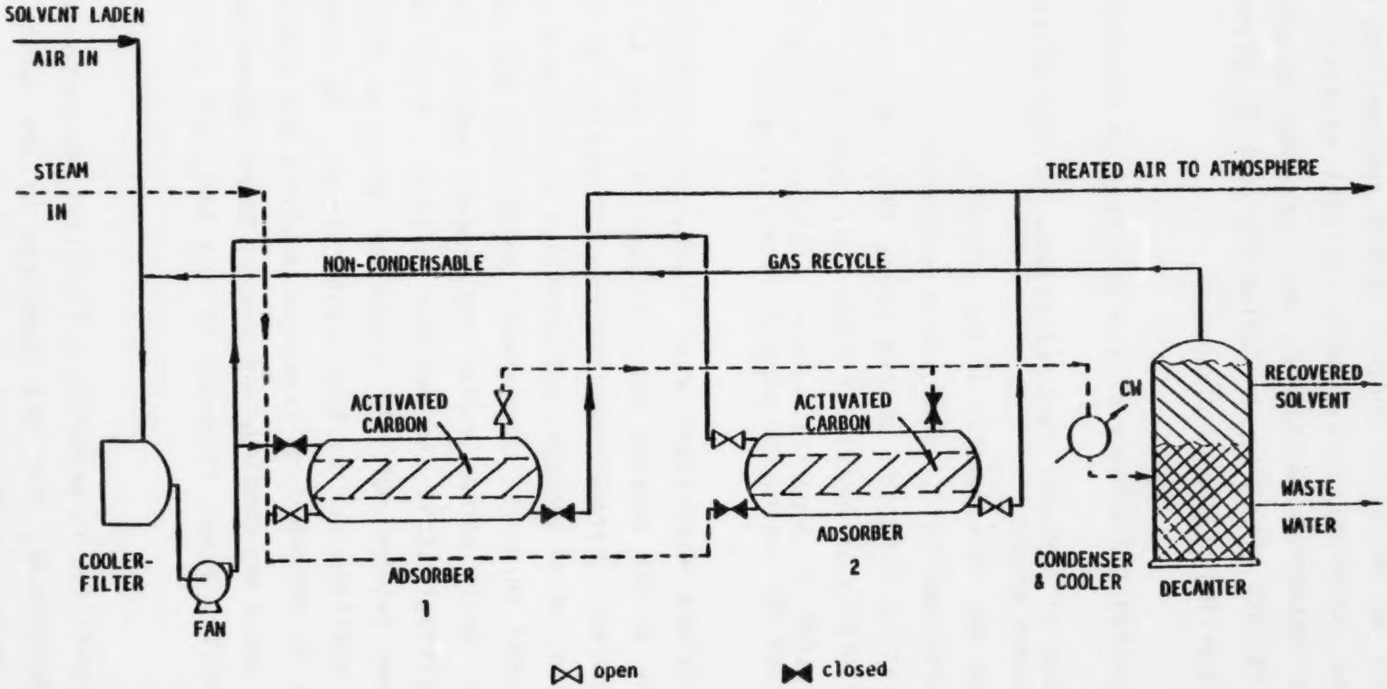
SOLVENT LADEN
AIR IN
STEAM
IN
NON-CONDENSABLE
GAS RECYCLE
TREATED AIR TO ATMOSPHERE
ACTIVATED
CARBON
ACTIVATED
CARBON
CW
RECOVERED
SOLVENT
WASTE
WATER
COOLER-
FILTER
FAN
ADSORBER
1
ADSORBER
2
CONDENSER
& COOLER
DECANTER
open
closed

FIGURE 7-1

FLOW DIAGRAM OF SOLVENT RECOVERY SYSTEM
(ADSORBER 1 REGENERATING)

Fixed-bed carbon adsorption systems for the packaging gravure industry are being marketed by at least three American firms. At least one firm can install an emissions control system encompassing press area capture systems, adsorber units, water/solvent distillation units, solvent mixture separation equipment, and recovered solvent storage. Plant specific factors affecting the design and cost of solvent capture, recovery, and recycling systems include:

- The required efficiency of the proposed or existing capture system;
- The range of solvent concentrations in the airstream from each capture system;
- The types and corrosiveness of the solvents;
- The desired quality of construction materials;
- The relative location of the press lines within the plant;
- The variability of individual press line usage; and
- The decision to separate solvent mixtures on-site or to sell the mixture for subsequent separation and reuse.[8,9]

Operational problems associated with fixed-bed adsorption systems include: carbon pellet erosion and disintegration due to mechanical abrasion and thermal degradation, buildup of residue on the carbon pellets, corrosion, valve leakage, and potential formation of azeotropes of water and alcohol solvents. Replaceable valve seals and seats reduce leakage problems, while carbon pellet replacement reduces the effects of erosion, disintegration, and residue buildup. Fixed bed carbon adsorption systems require multiple adsorption units so that printing operations may continue during bed regeneration. The length of an adsorption cycle is dependent on pressroom activity and system design. The regeneration cycle may continue for several hours, depending on steam generation capacity, steam flowrate in the bed, and cooling times required.

Union Carbide Corporation is marketing a fluidized bed carbon adsorption system, called Purasiv-HR, that was developed by the Kureha Chemical Corporation of Japan. A flow diagram of the Purasiv-HR system is presented as Figure 7-2. In the fluidized bed process, adsorption and desorption occur simultaneously in a single vertical vessel. The adsorbant is activated carbon beads. Solvent laden air is introduced into the bottom of the adsorption section and passes upward countercurrent to the fluidized activated carbon in a series of perforated trays. Carbon on each tray gradually flows downward from tray to tray as solvent adsorption increases. As it leaves the bottom tray of the adsorption section, the activated carbon is no longer fluidized and flows as a dense bed through the desorption section of the column. In the desorber, the adsorbent passes through the tube side of a shell-and-tube heat exchanger where indirect heating by steam or other heat transfer media raises it to the desorption temperature. The heat transfer media used for indirect heating is condensed and returned uncontaminated to the boiler. Desorption of solvent from the hot activated carbon is assisted by the introduction of direct contact stripping gas, usually nitrogen. The direct contact stripping gas reduces the partial pressure of the hydrocarbons and sweeps them from the bed in vapor form. The stripping gas, together with the vaporized solvent, passes from the desorber to a condenser where the solvent is recovered. The activated carbon leaving the bottom of the hot desorption section is first cooled and then air-conveyed to the top tray of the adsorption section. The nitrogen gas is recycled from the condenser back into the system for re-use. A secondary adsorber above the desorption section is used to properly condition the recycled nitrogen stream.[10]

Claimed advantages of the fluidized bed over the fixed bed adsorbers include:

- Continuous adsorption and desorption in a single vessel;
- The countercurrent flow of solvent laden air past the fluidized adsorbant allows maxmium adsorption capacity;
- The use of nitrogen stripping gas instead of steam minimizes water content in the recovered solvent, resulting in fewer vessel corrosion problems;
- Reduced installation costs;

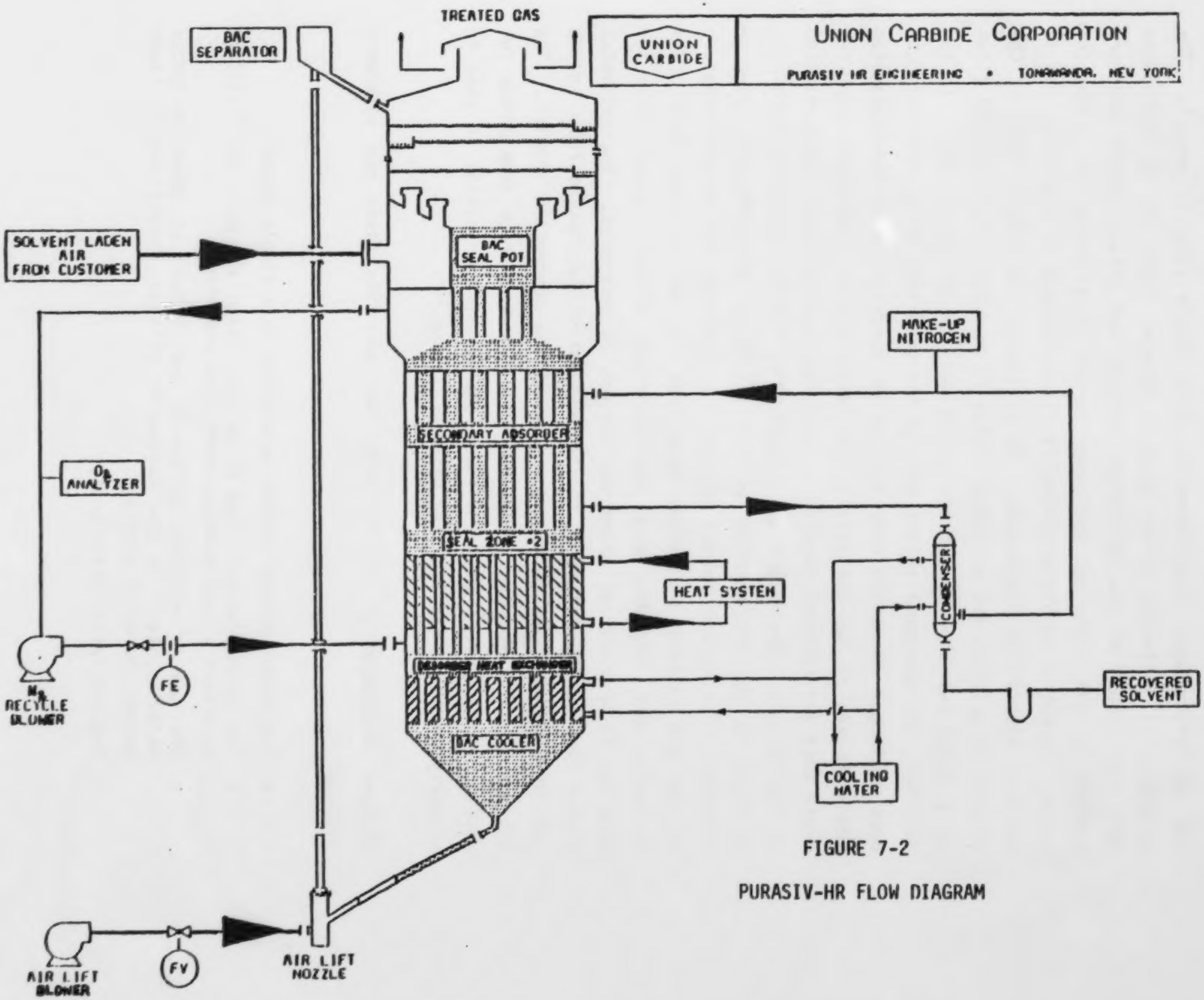
UNION CARBIDE
UNION CARBIDE CORPORATION
PURASIV HR ENGINEERING • TONAWANDA, NEW YORK
TREATED GAS
BAC SEPARATOR
SOLVENT LADEN AIR FROM CUSTOMER
BAC SEAL POT
MAKE-UP NITROGEN
SECONDARY ADSORBER
O_2 ANALYZER
SEAL ZONE #2
CONDENSER
HEAT SYSTEM
N_2 RECYCLE BLOWER
FE
DESORBER HEAT EXCHANGER
RECOVERED SOLVENT
BAC COOLER
COOLING WATER
AIR LIFT BLOWER
FV
AIR LIFT NOZZLE

FIGURE 7-2

PURASIV-HR FLOW DIAGRAM

- Reduced steam requirements;
- Reduced space requirements;
- Fewer moving parts; and
- Longer adsorbant life versus pelletized or granular activated carbon.[10]

Disadvantages of the fluidized bed system include:

- System air flow rate must remain relatively constant;
- Operating experience is less than that of fixed bed adsorbers; and
- Capital investment costs may be higher than for fixed bed systems.[1]

7.3.1.3 Incineration

Incineration destroys organic emissions by oxidizing them to carbon dioxide and water. There are no incineration systems currently being used on publication rotogravure plants in this country.[3] A previous survey of the flexible packaging industry indicated 5 of the 157 plants surveyed were equipped with incinerators. However, these units were either not operating or were associated with plant operations that did not involve flexographic printing. The survey of Ohio packaging gravure industry reveals a single plant having one of its presses equipped with an incineration system.[11] The type and operational status of the incineration system were not determined.

Industry sources were asked to comment on the packaging gravure and flexographic printing industries' apparant reluctance to install incineration systems. A compilation of their comments regarding the disadvantages of incineration system is:

- Capital and installation costs are high:
- Industry is concerned over long-term fuel availability and costs;
- Operating costs are high due to the discontinuous nature of printing operations and the length of time needed for incinerator start-up;

- For incineration systems configured for partial heat recovery, there may be no use for recovered heat unless existing presses' drying ovens are modified; and
- There are roof-top or ground-level installation problems associated with incineration systems.[12,13,14]

For the aforementioned reasons, and the lack of expressed desire from the Ohio packaging gravure and flexographic printing industries to consider incineration systems as an acceptable RACT compliance strategy, incineration systems are not further addressed in this study.

7.3.2 Water-Based Inks

The development of water-based inks used in packaging gravure and flexographic printing has been accelerated by the publication of EPA guideline documents and subsequent promulgation of regulations limiting VOC emissions from these printing operations.[14] Water-based inks now constitute a potential VOC emission control strategy for printing operations involving more types of substrates than was true three years ago. Management personnel from the majority of printing plants listed in Tables 7-2 and 7-3 indicate that the increased use of water-based inks represents the preferred RACT compliance strategy at their plants.

The use of water-based inks is an attractive RACT compliance strategy since it represents a lower capital investment compared to either carbon adsorption or incineration systems.[15] While ink manufacturers and representatives of printing industry professional organizations can identify potential problem areas or benefits resulting from a conversion to water-based inks, the overall impact upon the packaging gravure and flexographic printing industries is difficult to estimate for many reasons, including:

- The multitude of solvent-based ink/substrate combinations found in these industries;
- The continuing development of water-based inks potentially suitable as alternatives to solvent-based inks; and
- The unavailability of cost and operational experience information compiled and analyzed for a sufficient number of plants that have already converted to water-based inks.

The paucity of cost and operational experience information causes industry sources to be reluctant to estimate industry average or even ranges of cost savings or increases associated with a conversion to water-based inks. Sources contacted agree that water-based inks are currently more expensive than the solvent-based inks they may eventually replace. However, the magnitude of the cost differential is highly dependent on the associated substrate and the solvent-based inks being compared. Current estimates are that water-based inks cost the printing industry an average of 10 to 15 percent more than solvent-based inks, but that this cost differential will decrease as solvent costs continue to increase and development costs passed on to the consumer decrease.[16,17] There may be a crossover in comparative solvent and water-based ink prices in the latter half of the decade.[16,18] For the purposes of this study, it is assumed that the average cost of water-based inks is presently 15 percent higher than that of the solvent-based inks replaced.

The desirability of converting to water-based inks cannot be judged solely on the basis of ink costs. Several operational considerations must also be evaluated. Gravure cylinders used with solvent-based inks may not produce the same quality printing if used with water-based inks.[19,20] In general, water-based inks transfer onto the substrate more efficiently than solvent-based inks. Therefore, to avoid excessive ink deposition on the substrate, the technique used to engrave the cylinders must be modified. The cost of obtaining gravure cylinders suitable for use with water-based inks should not differ significantly from that for cylinders compatible with solvent-based inks. From an operational standpoint, however, the impact of procuring new cylinders for use with water-based inks will depend on the amount and nature of repeat printing tasks performed at a given printing plant. Rather than being able to replace cylinders only as they become damaged or worn, a plant may have to replace the entire set of cylinders used for a repeat customer's printing job, once the use of water-based inks has been authorized. It is assumed that the cost of procuring cylinders compatible with water-based inks is identical to that for cylinders used with solvent-based inks.

With respect to the flexographic printing, there is some concern that a press' ink metering system may require modification if printing done with water-based inks is to be of equivalent quality to that done using solvent-based inks.[17] No additional information on this potential problem area is available. Consequently, any costs associated with modifying a flexographic press line's ink metering system due to a conversion to water-based inks will not be considered in this study.

Another operational concern regarding a conversion to water-based inks is drying time. The magnitude of the increase in drying times is dependent upon the inks being compared, substrate absorbancy, and the design and operational characteristics of the press line's dryers. Improvements in drying time could be realized by increasing the quantity of heated air contacting the substrate, increasing the temperature of the drying air, or decreasing the press' operating speed. The amount of temperature increase is limited by the substrate. The amount of press speed decrease is limited by the decrease in profit that can be tolerated. In the absence of industry cost estimates for implementing any of these alternatives, costs incurred in modifying press equipment or operational procedures to improve ink drying characteristics are not be addressed in this study.

7.3.3 High Solids Inks

High-solids inks have not more than 40 percent solvent content by volume, excluding water. High-solids inks include resins, so that less solvent is needed to reduce ink viscosity to levels required for application. Coatings have been developed with a low-viscosity vehicle that polymerizes rapidly by reaction with some other component or by action of ultraviolet or electron-beam radiation. Such measures are necessary to affix the ink to the substrate.[3]

While high-solids inks have been tried in other segments of the printing industry, their use is not yet feasible for gravure and flexographic printing applications.[15] There is, however, some future for high-solids inks, particularly for non-absorbant substrates.[16]

Due to the state of high-solids ink technology with respect to packaging gravure and flexographic printing, this VOC emission control strategy is not be further addressed in this study.

7.3.4 Model Plant Formulation

Model plant configurations are used in this study to develop estimated costs to the Ohio flexible packaging industry for implementing acceptable RACT compliance strategies.

Management at plants identified in Section 7.2 consider either the installation of carbon adsorption systems or the increased use of water-based inks to be the only acceptable compliance strategy for their plants The extent to which either strategy is being investigated or adopted at these plants is generally considered proprietary information. Model plant parameters presented in this section are based on information presented in U.S. EPA publications and general guidance from industry sources.

7.3.4.1 Model Plant Parameters for Plants Converting to Water-Based Inks

The cost differential between water and solvent-based inks is assumed to be the only parameter required to estimate the cost of implementing a compliance strategy based on the use of water-based inks. It is assumed that costs to implement any equipment or operational changes eventually determined necessary to produce a satisfactory product printed with water-based inks will not be prohibitive. It is also assumed that the average cost of water-based inks utilized as a RACT compliance strategy is 15 percent higher than that of the solvent-based inks they replace.

7.3.4.2 Model Plant Parameters For Plants Equipped with Carbon Adsorption Systems

Suppliers of solvent recovery systems cite a number of plant-specific variables that greatly affect control system design and, therefore, total cost.

Some suppliers include the upgrading of existing or the design and installation of new vapor capture systems in their scope of services. In this study, it is assumed that a company selecting carbon adsorption systems as their compliance strategy already has pressroom vapor capture systems that meet the efficiency requirements of Ohio's RACT regulations.

Since complex mixtures of solvents are commonly used in flexible packaging printing operations, a major decision is whether to install solvent mixture separation, purification, and storage equipment onsite or to arrange for solvent mixture disposal by another firm. The latter will be assumed in this study.

Although the total cost of a solvent recovery system is a function of many variables, system suppliers and a recent U.S. EPA publication utilize capture system exhaust volumetric flow rate and VOC concentration in the exhaust as the critical parameters in control system cost estimations. The volumetric flow rate and concentration combinations presented in Table 7-4 are assumed representative for the Ohio flexible packaging industry plants affected by the RACT regulations. The average actual press operating time is assumed to be 3430 hours per year, based on 4900 scheduled operating hours per year and 30 percent press idle time.[5]

7.3.5 Estimated VOC Emissions After Implementation of RACT

Ohio's RACT regulations apply to gravure and flexographic operations capable of emitting at least 100 tons per year of VOC. The state's only publication gravure plant remaining operational beyond 1982 has been

TABLE 7-4

PROCESS PARAMETERS FOR MODEL PLANT CONFIGURATIONS INCORPORATING CARBON ADSORPTION SYSTEMS FOR VOC EMISSIONS CONTROL

TOTAL SOLVENT CONCENTRATION IN CAPTURE SYSTEMS EXHAUST (ppm)	TOTAL EXHAUST FROM CAPTURE SYSTEMS (scfm)	AVERAGE PRESS[a] OPERATING TIME (hrs/yr)	ANNUAL PLANT[b] VOC EMISSIONS (tons/yr)
250	20,000	3,430	131.7
	50,000	3,430	329.3
	100,000	3,430	658.6
500	20,000	3,430	263.4
	50,000	3,430	658.6
	100,000	3,430	1317.2
750	20,000	3,430	395.2
	50,000	3,430	987.9
	100,000	3,430	1975.8

[a] U.S. EPA, 1981.

[b] $\text{VOC (ton/yr)} = \dfrac{(\text{ppm})(\text{scfm})(3{,}430\ \text{hrs/yr})}{(65100)\ (2000\ \text{lb/ton})}$

equipped with a solvent recovery system for some time. Therefore, the economic impact of Ohio's RACT regulation on the publication gravure industry is not addressed in this study. The estimation of total annual VOC emission reductions due to the implementation of RACT is based on emission reductions from plants satisfying the following criteria:

- Packaging gravure or flexographic printing operations will continue beyond 1982; and
- In reaction to the RACT regulation, plant management is now in the process of investigating or implementing measures to reduce VOC emissions.

As indicated in Tables 7-2 and 7-3, sixteen plants are determined to satisfy these criteria. Both flexography and package gravure printing is done at two of the affected plants. Annual emissions data are available from the 1979 Ohio EIS for 13 of the 16 plants. For the remaining 3 plants, annual VOC emissions from each of these plants are estimated to be 367 tons per year, which is the average of the 1979 annual emissions from the 5 facilities listed in Table 7-3 at which only flexographic printing is performed. Therefore, total VOC emissions from printing plants subject to the RACT regulations are estimated to be 8002 tons per year.

7.3.5.1 Estimated Annual VOC Emission Reductions From Plants Converting to Water-Based Inks

Management at 14 affected facilities indicate that the increased use of water-based inks is their present RACT compliance strategy. The extent to which water-based inks can actually replace solvent-based inks at all plants will not be known for some time. In this study, it is assumed that all 14 facilities will comply with the RACT regulations by totally converting to water-based inks.

The estimated annual VOC emissions from these 14 plants are 6,491 tons per year. Package gravure and flexography printing utilize a variety of inks which contain different percentages of volatile solvents, ranging from about 50 to 96 percent.[1] For solvent-based inks, an average volatile solvent content of 75 percent is assumed in this study.[1,3] Per Ohio Rule 3745-21-09(Y), the volatile organic compound content of a compliance ink cannot exceed 25 percent by volume of the ink's volatile content. Therefore, assuming identical solvent and water-based ink consumption (i.e., identical solids content) before and after implementation of RACT and 100 percent plant conversion to water-based inks having 18.75 percent volatile solvent content, the estimated annual reduction in VOC emissions from these 14 plants is 4,868 tons per year.

7.3.5.2 Estimated Annual VOC Emission Reductions From Plants Installing Solvent Recovery Systems

Management at two plants indicate that the installation of solvent recovery systems is their present RACT compliance strategy. It is assumed that this compliance strategy will be implemented at only these two plants.

Suppliers of fixed or fluidized bed carbon adsorption systems claim a solvent vapor removal efficiency from capture system exhaust of about 96 to 97 percent.[9,21] It is conservatively assumed that the adsorber units will operate at an overall average 90 percent VOC removal efficiency, as is required by the RACT regulation. Assuming the plant's existing capture systems meet the regulations' 70 percent efficiency requirement, the annual reduction in VOC emissions from these plants can be estimated from the 1979 Ohio EIS data and an average 90 percent solvent recovery per absorber unit. The 1979 VOC emissions from the two plants totaled 1,511 tons per year. The estimated reduction in VOC emissions from plants assumed to eventually install solvent recovery systems is about 952 tons per year.

7.3.5.3 Estimated VOC Emissions After Implementation of RACT

The estimated annual VOC emissions before and after the implementation of RACT are summarized in Table 7-5. Total VOC emission reduction is estimated as 5,820 tons per year.

TABLE 7-5

ESTIMATED ANNUAL VOC EMISSION REDUCTIONS AFTER IMPLEMENTATION OF RACT COMPLIANCE STRATEGY

PARAMETER	CONVERSION TO[a] WATER-BASED INKS	INSTALLATION OF[b] SOLVENT RECOVERY SYSTEM	TOTAL
Number of Plants	14	2	16
Estimated Annual VOC Emissions Before RACT (tons/yr)	6,491	1,511	8,002
Estimated Annual VOC Emissions After RACT (tons/yr)	1,623	559	2,182
Estimated Annual Reduction in VOC Emissions Due to RACT (tons/yr)	4,868	952	5,820

[a] Based on average solvent contents of 75 percent in solvent-based inks and 18.75 percent in water-based inks.

[b] Based on capture system efficiency of 70 percent and control system efficiency of 90 percent.

7.4 COST ANALYSES

The costs of controlling VOC emissions from affected packaging gravure and flexographic printing plants are estimated using model plant parameters formulated for the currently preferred control strategies at the affected plants.

7.4.1 Conversion to Water-based Inks

As indicated in Section 7.3, the total cost of complying with the RACT regulation that is incurred by plants adopting a water-based ink compliance strategy is assumed to be the cost difference between water and solvent-based inks used at these facilities. In general, the cost of the pigment is a more important factor than the cost of the solvents in inks used by the packaging gravure and flexographic printing industries. The most commonly used inks are white. The current cost of solvent-based, white inks used by these industries is about $1.00 per pound. The costs for other colors are higher, due to higher pigment costs.[22] The estimated industry average price for solvent-based inks used in Midwestern packaging gravure and flexographic printing is about $1.30 per pound.[23] This value, equivalent to $2600 per ton of ink, is assumed representative of ink costs to Ohio packaging gravure and flexographic printers. Assuming that water-based inks currently are an average 15 percent more expensive than solvent-based inks, the estimated average cost of water-based inks is $1.50 per pound ($3000 per ton).

The estimated costs of achieving compliance for affected plants assumed to convert to 100 percent water-based ink usage and summarized in Table 7-6. These facilities will incur an estimated average cost of $800 per ton ($0.88 per kilogram) reduction in VOC emissions, based on estimated current ink costs. This cost of achieving compliance should decrease as water-based ink costs decrease relative to those of solvent-based inks.

TABLE 7-6

ESTIMATED COSTS FOR CONVERSION TO WATER-BASED INKS

PARAMETER	VALUE
Estimated VOC emissions before RACT (tons/yr)	6,491
Average solvent content in solvent-based inks (%)	75.00
Average solvent content in water-based inks (%)	18.75
Average solvent retention in substrates[a] (%)	3.5
Estimated ink consumption[b] (tons/yr)	8,655
Estimated increased cost for water-based inks ($/ton)	400
Estimated increased ink cost ($/yr)	3,462,000
Estimated VOC reduction due to implementation of RACT (tons/yr)	
Cost effectiveness ($/ton VOC reduction) ($/kg VOC reduction)	800 0.88

---

[a] Range of solvent retention is negligible to about 7 percent.

[b] Solvent or water-based inks.

7.4.2 Carbon Adsorption Systems

Installation and operation costs for carbon adsorption systems can be estimated using model plant parameters presented in Table 7-4 and equations developed for the EPA.[5] The installation cost for carbon adsorption systems, including site preparation and system piping and duct work, are primary functions of the vapor capture systems exhaust gas volumetric flow rates (VFR) and the VOC concentration in the exhaust gas, as indicated in the following equation:

$$I = [2.7][(8.1)(VFR) + 17800]\,[1 + (C/3500)]$$

where:
I is the total estimated installation cost in dollars;
VFR is expressed in units of standard cubic feet per minute (scfm); and
C is solvent vapor concentration in parts per million (ppm).

Equations developed for annual operating costs are summarized below:

Steam Cost (SC) = (3.5)($9/1,000 lb steam)(V lb/hr)
Water Cost (WC) = (VFR)(H)($0.30/1,000 gal)
Carbon Replacement (CR) = ($0.14)(VFR)
(based on 10% replacement/yr at $1.27/lb)
Condensate Treatment (CT) = ($0.22)(V lb/hr)
(for contract disposal)

where:

V is amount of VOC contained in the capture systems' exhaust gas;
VFR is volumetric flow rate (scfm); and
H is operating hours (hrs/yr).

Estimated adsorption system installation and annual operating costs for the model plant configurations are presented in Table 7-7. The largest operating cost is associated with recovered solvent mixture treatment and disposal.

TABLE 7-7

ESTIMATED INSTALLATION AND ANNUAL OPERATING COSTS FOR SOLVENT RECOVERY SYSTEMS

MODEL PLANT NO.	TOTAL SOLVENT CONCENTRATION IN CAPTURE SYSTEMS EXHAUST (ppm)	TOTAL EXHAUST FROM CAPTURE SYSTEMS (scfm)	ESTIMATED INSTALLATION COSTS (nearest $1,000)	ANNUAL OPERATING COSTS ($)*				
				STEAM	WATER	CARBON REPLACEMENT	CONDENSATE DISPOSAL	TOTAL
1	250	20,000	520,000	8,297	20,580	2,800	57,948	89,625
2	250	50,000	1,223,000	20,746	51,450	7,000	144,892	224,088
3	250	100,000	2,395,000	41,492	102,900	14,000	289,784	448,176
4	500	20,000	555,000	16,594	20,580	2,800	115,896	155,870
5	500	50,000	1,305,000	41,492	51,450	7,000	289,784	389,726
6	500	100,000	2,554,000	82,984	102,900	14,000	579,568	779,452
7	750	20,000	589,000	24,898	20,580	2,800	173,888	222,166
8	750	50,000	1,386,000	62,238	51,450	7,000	434,676	555,364
9	750	100,000	2,714,000	124,475	102,900	14,000	869,352	1,110,727

*Based on 3,430 operating hours per year.[5]

Solvent recovery is the preferred control strategy at two Ohio package gravure plants. Although 1979 annual VOC emissions data are available for both plants, pressroom configuration, and press and capture system design and operational information are not available. It is assumed that recovered solvent mixtures will be disposed of by an independent contractor, rather than being recycled onsite or sold for reprocessing and subsequent resale by another firm.

Annual VOC emissions from the two plants at which solvent recovery systems is the preferred control strategy are 1,511 tons per year. It is assumed that model plants No. 5 and No. 8 provide representative cost estimates for facilities capable of emitting roughly 750 tons of VOC annually. Assuming presslines operate 3,430 hours per year, annual emissions from model plants Nos. 5 and 8 bracket an emissions value of about 750 tons per year. Annualized cost estimates for model plants Nos. 5 and 8, presented in Table 7-8, include capital charges and operating and maintenance costs. Capital charges cover a capital recovery factor to account for interest and depreciation and a 4 percent factor for property taxes, insurance, and administrative costs. The capital recovery factor (CRF), defined in Chapter 1 of this study, is 17.7 percent, based on an annual interest rate of 12 percent and an equipment life of 10 years. The total capital charge factor is, therefore, estimated as 21.7 percent of the installed capital costs.

Annual operating costs were estimated using equations developed for the EPA.[5] Contract disposal of solvent at a cost of $65 per drum is assumed. From Table 7-7, this method of recovered solvent handling represents 64.7 to 78.7 percent of the total estimated annual operating costs. Depending on local market conditions, should recovered solvent be sold for reuse rather than being disposed of at a cost to the printer, overall annual operating costs could be reduced significantly.

7.5 OVERALL COST EFFECTIVENESS

The overall estimated cost effectiveness for the segments of the printing industry affected by Ohio's RACT regulation is presented in Table 7-9.

TABLE 7-8

ESTIMATED COSTS FOR SOLVENT RECOVERY SYSTEMS FOR TWO MODEL PLANT CONFIGURATIONS

PARAMETER	MODEL PLANT CONFIGURATIONS NO. 5	MODEL PLANT CONFIGURATIONS NO. 8
Installed Capital Cost ($\$10^3$)	1305.0	1386.0
Annual Operating Cost ($\$10^3$)	389.7	555.4
Annualized Capital Charges[a] ($\$10^3$)	283.2	300.8
Total Annual Cost ($\$10^3$)	672.9	855.2
Solvent Recovered[b] (tons/yr)[d]	415	622
Cost Effectiveness[c]		
($/tons recovered)	1621.	1375.
($/kg recovered)	1.79	1.52

[a] Based on an estimated equipment life of 10 years and a capital charge factor of 21.7 percent.

[b] Based on capture system efficiency of 70 percent and control system efficiency of 90 percent.

[c] Based on a 90 percent VOC removal efficiency, the minimum efficiency required by the RACT regulation.

[d] No credit for solvent recovery.

TABLE 7-9

CONTROL COST SUMMARY FOR AFFECTED PLANTS

PARAMETER	CONVERSION TO WATER-BASED INKS	CARBON ADSORPTION SYSTEM	TOTAL CONTROL COSTS
Number of Plants	14	2	
Installed Capital Cost ($$10^3$)	-	2691.0	2691.0
Annualized Capital Charges ($$10^3$)	-	583.9	583.9
Annual Operating Costs ($$10^3$)	3631.2	945.1	4576.3
Total Annual Costs ($$10^3$)	3631.2	1528.1	5159.3
VOC Reduction*			
(tons/yr)	4,868	952	5,820
(kg/yr)	4,416,175	507,125	4,923,300
Cost Effectiveness*			
($/ton VOC reduction)	800.	1605.	866.
($/kg VOC reduction)	0.88	3.01	1.05

*For plants equipped with carbon adsorption systems, based on actual emissions and 70 percent capture system efficiency and 90 percent control system efficiency.

The overall cost effectiveness of controlling VOC emissions will be improved when one or more of the following conditions occur:

- Water-based ink prices become more competitive to those of solvent-based inks. As indicated in Section 7.3.2, there may even be a crossover in comparative solvent and water-based ink prices in the latter half of this decade. This possible price crossover, in conjunction with the time extension allowed in Ohio Rule 04(C)(32)(b) for water-based research programs, may result in a net savings for those converting to water-based inks;
- Facilities equipped with carbon adsorption systems utilize inks whose solvents are recyclable with minimal separation and other reprocessing problems; and
- Facilities equipped with carbon adsorption systems successfully market recovered solvent mixtures or otherwise minimize disposal costs.

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8.0 STORAGE OF PETROLEUM LIQUID IN EXTERNAL FLOATING ROOF TANKS

8.1 Introduction

Storage tanks for petroleum liquids are a significant source of VOC emissions. The Ohio EPA had earlier implemented a regulation to control VOC emissions from fixed roof tanks by requiring a retrofit with internal floating roofs or their equivalent. The analysis presented here is to determine the economic impact of controlling VOC emissions from external floating roof tanks storing petroleum liquids. The Ohio EPA adopted a regulation for this source category that requires installation of a rim-mounted secondary seal or any other seal, closure, or device with equivalent effectiveness. Exempted from this control requirement are those tanks which (a) have a storage capacity of less than 40,000 gallons, (b) have a storage capacity of less than 420,000 gallons and which store produced crude oil or condensate prior to custody transfer, (c) store petroleum liquids with true vapor pressure less than 1.5 psia, and (d) contain crude oil with a pour point of 50°F or higher.

8.2 Inventory of Affected Facilities

The number of affected external floating roof tanks was estimated by reviewing the state inventory information. Since the regulation exempts the storage of vapor pressure of less than 1.5 psia, only the storage of gasoline, crude oil and naphtha petroleum liquids was considered in identifying the affected tanks. All other petroleum liquids have vapor pressures below 1.5 psia, as is evident from Table 8-1, which lists the average vapor pressure values for different petroleum liquids. Similarly, other exempted categories, as listed in Section 8.1, were also considered while identifying the affected external floating roof tanks.

The list of affected external floating roof tanks, as developed from the state inventory, was sent to the Ohio EPA for review and comments. The storage capacities of the tanks were also included in the listed information so they could be verified. The comments received from the Ohio EPA on the list of affected tanks and their storage capacities were subsequently incorporated in the final inventory information.

TABLE 8-1. VAPOR PRESSURE OF VARIOUS PETROLEUM LIQUIDS

Petroleum Liquid	True Vapor Pressure at 289°k (psia)
Gasoline	5.2
Naphtha	3.5
Jet Fuel	1.3
Benzene	1.2
Kerosene	0.0085
Diesel Fuel	0.0074
Residual Fuel Oil	0.00004
Crude Oil	2.0[a]

---

[a] Crude oil vapor pressure varies over a wide range depending on the crude oil source. 2.0 psia is an average value taken from Reference 1.

The total number of affected external floating roof tanks was estimated to be 279, with 263 tanks storing gasoline, 12 tanks storing crude oil and 4 tanks storing naphtha. Since not all tanks are registered in the Ohio Air Permit System, the actual number of tanks affected by this regulation is likely to be considerably higher. A geographical distribution of the affected tanks is presented in Figure 8-1. The size distribution of affected gasoline storage tanks in terms of storage capacity is given in Table 8-2. The storage capacity information was actually available for only 198 tanks (from the total of 263 gasoline storage tanks), and the size distribution of these tanks was used to project the size distribution of all the affected gasoline tanks.

The uncontrolled VOC emissions from the affected gasoline storage tanks and the potential reduction in these emissions were estimated by formulating eight model tanks representing each of the eight size classifications in Table 8-2. Table 8-3 gives the model tank parameters and the emission data for the affected gasoline storage tanks. Model tank dimensions (diameter, height) given in Table 8-3 were estimated by contacting storage tank vendors. The uncontrolled VOC emission estimates were made by using the relationship given in Table 8-4. Using this relationship, uncontrolled VOC emissions from affected gasoline storage tanks were estimated to be 2,337 tons/year.

For tanks storing crude oil and naphtha, one model tank was considered for each of the two petroleum liquids. Table 8-5 gives the technical parameters for these model plants. Uncontrolled VOC emissions from these tanks were estimated to be approximately 78 tons/year. The total uncontrolled VOC emissions from all the affected tanks storing volatile petroleum liquids (gasoline, crude oil, and naphtha) were estimated to be approximately 2,415 tons/year.

8.3 Alternative VOC Control Measures

VOC emissions from external floating roof tanks can be controlled by retrofitting these tanks with a shoe-mounted secondary seal or a rim-mounted secondary seal. A shoe-mounted secondary seal is commonly

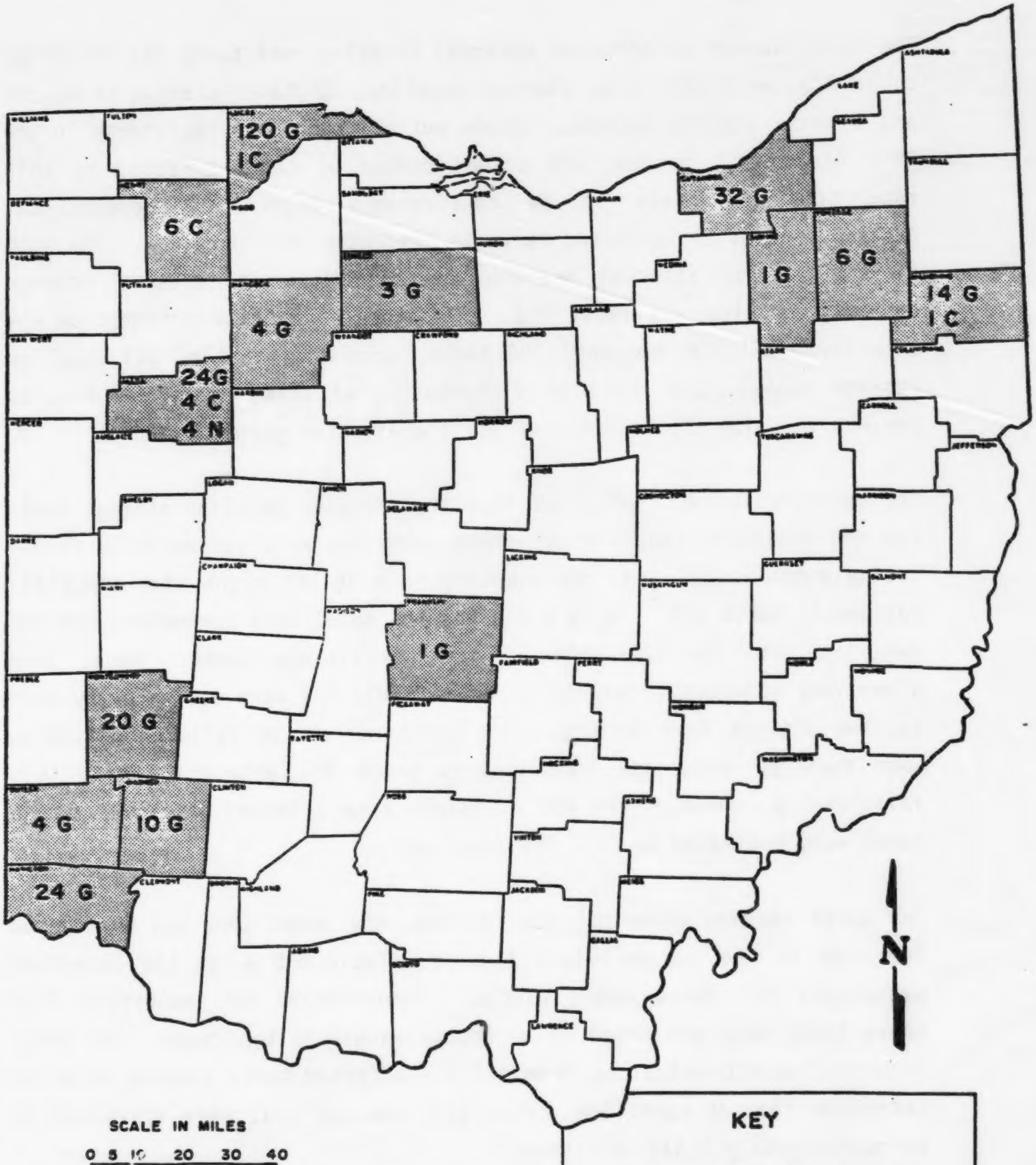
120 G
1 C
6 C
3 G
4 G
24G
4 C
4 N
32 G
1 G
6 G
14 G
1 C
1 G
20 G
4 G
10 G
24 G
N
SCALE IN MILES
0 5 10 20 30 40
KEY
G - Gasoline Storage Tank
C - Crude Oil Storage Tank
N - Naphtha Storage Tank
Ex. 15 C - 15 Crude Oil Storage Tanks

FIGURE 8-1 GEOGRAPHICAL DISTRIBUTION OF AFFECTED EXTERNAL FLOATING ROOF STORAGE TANKS IN OHIO

TABLE 8-2. SIZE DISTRIBUTION OF AFFECTED GASOLINE STORAGE TANKS

Storage Capacity ($x10^3$ gallons)	Average Value ($x10^3$ gallons)	Number of Tanks Sample	Number of Tanks Population[a]
Less than 950	475	56	74
950 - 1,900	1,425	50	67
1,900 - 2,850	2,375	19	25
2,850 - 3,800	3,325	30	40
3,800 - 4,750	4,275	10	13
4,750 - 5,700	5,225	9	12
5,700 - 6,650	6,175	23	31
6,650 - 7,600	7,125	1	1
		198	263

[a] Extrapolated from the sample data.

TABLE 8-3. MODEL TANK PARAMETERS AND EMISSION DATA FOR GASOLINE STORAGE TANKS

Model Tank	Storage Capacity ($x10^3$ gallons)	Diameter	Height	Number of Storage Tanks Represented	Uncontrolled Emissions (tons/yr/tank)	Control Efficiency[a] (%)	Emission Reduction (tons/yr/tank)
#1	475	45	40	74	4.42	75	3.32
#2	1,425	78	40	67	7.66	75	5.75
#3	2,375	100	40	25	9.82	75	7.37
#4	3,325	119	40	40	11.69	75	8.77
#5	4,275	123	48	13	12.08	75	9.06
#6	5,225	136	48	12	13.36	75	10.02
#7	6,175	148	48	31	14.54	75	10.91
#8	7,125	159	48	1	15.62	75	11.72

Uncontrolled emissions from the affected EFR gasoline storage tanks = 2,337 tons/yr.

Potential reduction in emissions from the affected EFR gasoline storage tanks = 1,753 tons/yr.

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[a] Assuming welded tanks with rim-mounted secondary seals.

TABLE 8-4. RELATIONSHIP TO ESTIMATE UNCONTROLLED VOC EMISSIONS FROM EXTERNAL FLOATING ROOF TANKS[a]

$$E_f = 1.2337 \text{ x } 10^{4} \; \frac{P_f}{1 + (1-.068P_f)^{0\;5\;2}} \text{ x } D_f \text{ x } M_{hc} \text{ x } E_p$$

Where

E_f = Emissions from the model tank

E_p = Emissions from test tank at 5.0 p.s.i., lbs/day (estimated to be 7.3 lbs/day based on data in Reference 3 and an average wind speed of 10 m.p.h in ohio)

P_f = Vapor pressure of product stored in the model tank

D_f = Diameter of the model tank, feet

M_{hc} = Hydrocarbon vapor molecular weight = 65

---

[a] Source: Reference 3.

TABLE 8-5. EMISSION DATA AND MODEL PLANT PARAMETERS AFFECTED CRUDE OIL AND NAPHTHA STORAGE TANKS

	Crude Oil	Naphtha	Total
Number of tanks	12	4	16
Model tank capacity (10^3 gallons)	3,275	3,051	
True vapor pressure (psi)	2.0	3.5	
Model tank dimensions			
Diameter (feet)	118	114	
Height (feet)	48	48	
Model tank uncontrolled emissions (tons/yr)	4.1	7.3	
Total uncontrolled emissions (tons/yr)	49.2	29.2	78.4
Control efficiency (%)	75	75	
Emission reductions (tons/yr)	37	22	59

installed on external floating roofs. It extends from the top of the shoe to the tank wall. However, shoe-mounted secondary seals do not provide any control for VOC emissions escaping through any opening in the primary seal envelope.

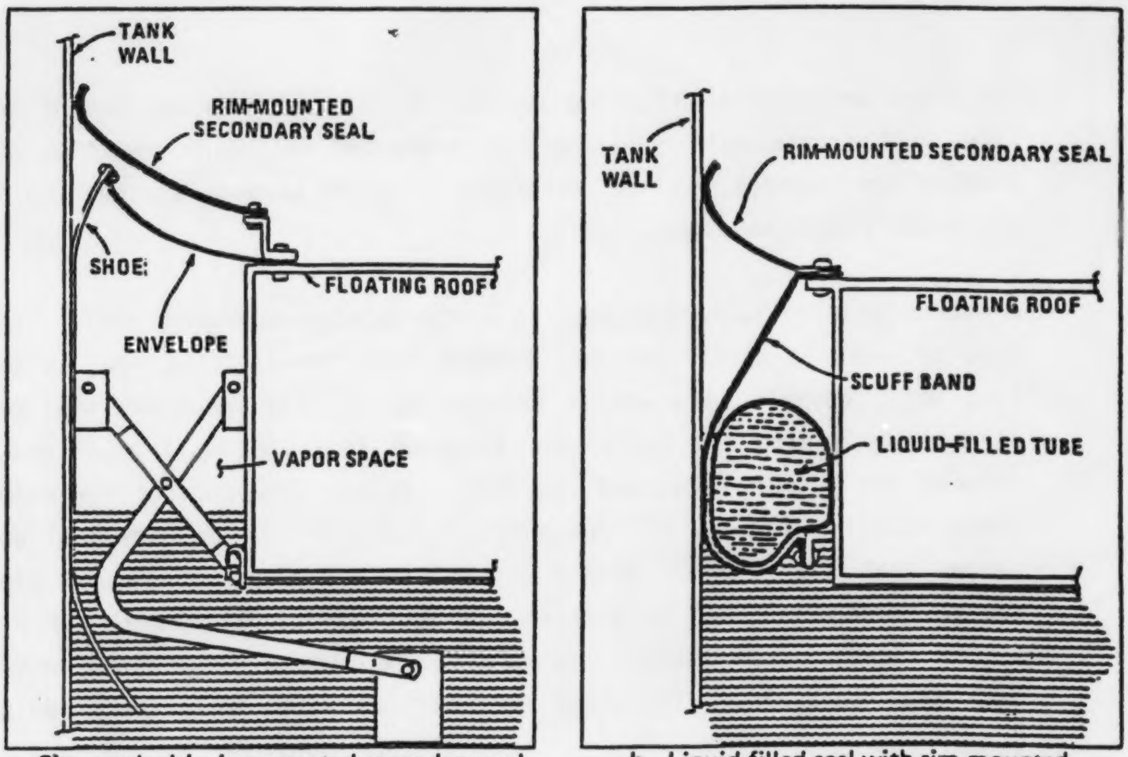
A second type of secondary seal is a rim-mounted secondary seal. This type of seal is continuous and extends from the floating roof to the tank wall, covering the entire primary seal. This secondary seal can effectively control VOC emissions escaping from the small vapor space between the primary seal and the wall. It can also control VOC emissions escaping through any openings or tears in the primary seal envelope that would permit direct contact with the atmosphere. A rim-mounted secondary seal is therefore a more efficient control for external floating roof tanks. Figure 8-2 shows how a rim-mounted secondary seal works when installed over various types of primary seals.

The proposed Ohio EPA regulation to control VOC emissions from external floating roof tanks requires these tanks to be retrofitted with a rim mounted secondary seal. The control efficiency of this secondary seal depends on the tank construction and also on the type of primary seal in the tank. The EPA Control Technique Guideline (CTG) document on the control of VOC emissions from external floating roof tanks specifies the following control efficiencies for rim-mounted secondary seals for three combinations of tank construction and type of primary seal:

Case I - Welded tank with the following primary seals--shoe seal, liquid-mounted foam seal, or liquid-mounted liquid-filled seal - 75 percent control efficiency.

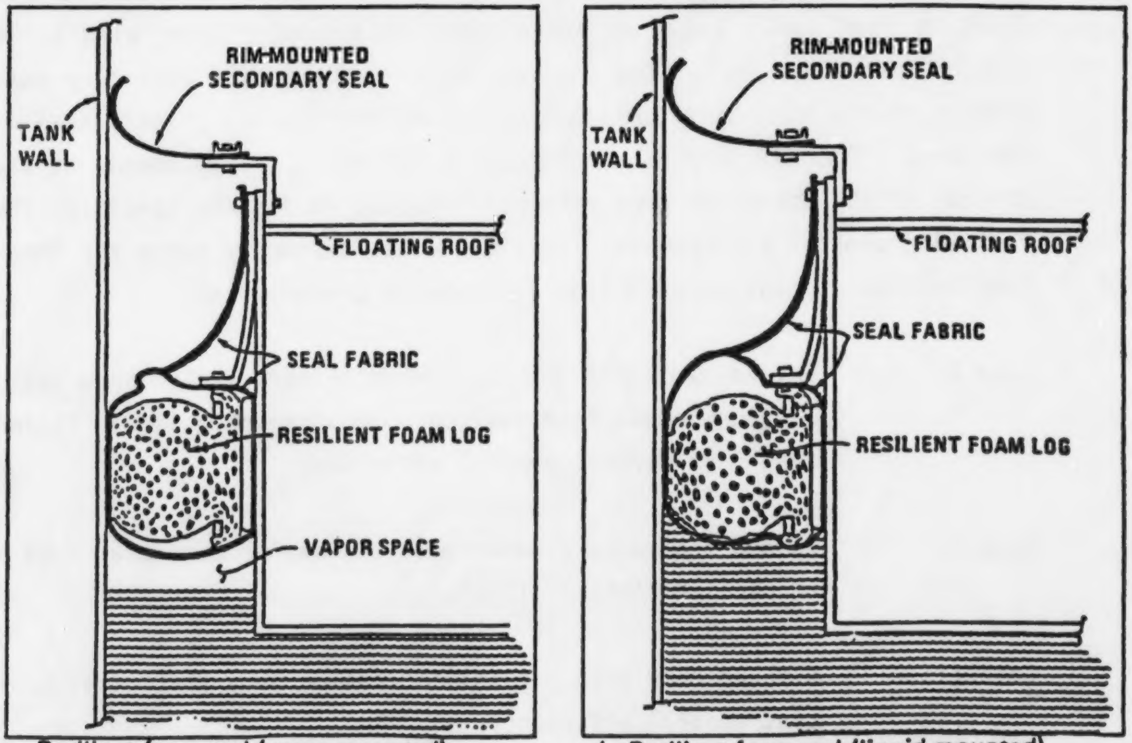
Case II - Welded tank with a vapor-mounted foam primary seal-- 84 - 88 percent control efficiency.

Case III - Riveted tank with a metallic shoe primary seal -- 45 percent control efficiency.


TANK WALL
RIM-MOUNTED SECONDARY SEAL
SHOE
ENVELOPE
FLOATING ROOF
VAPOR SPACE
TANK WALL
RIM-MOUNTED SECONDARY SEAL
FLOATING ROOF
SCUFF BAND
LIQUID-FILLED TUBE

a. Shoe seal with rim-mounted secondary seal

b. Liquid-filled seal with rim-mounted secondary seal


RIM-MOUNTED SECONDARY SEAL
TANK WALL
FLOATING ROOF
SEAL FABRIC
RESILIENT FOAM LOG
VAPOR SPACE
RIM-MOUNTED SECONDARY SEAL
TANK WALL
FLOATING ROOF
SEAL FABRIC
RESILIENT FOAM LOG

c. Resilient foam seal (vapor-mounted) with rim-mounted secondary

d. Resilient foam seal (liquid-mounted) with-rim-mounted secondary seal

FIGURE 8-2 RIM - MOUNTED SECONDARY SEALS

Personal communication with a supplier of storage tanks[4] indicated that welded tanks were the most common type of tanks being erected and used in the industry in the large-size range. Therefore, it was assumed that the affected tanks are welded tanks with any of the following primary seals--shoe seal, liquid-mounted foam seal or liquid-mounted liquid-filled seal..

8.4 Cost Analysis

The costs of controlling VOC emissions from the affected tanks were estimated by formulating model tanks to represent the whole population. As mentioned earlier, eight model tanks were developed for the affected gasoline storage tanks and one each for the crude oil storage and naphtha storage tanks. Technical parameters for these model tanks are presented in Table 8-3 (for gasoline storage tanks) and in Table 8-5 (for crude oil and naphtha storage tanks). The capital costs of installing a rim-mounted secondary seal on these model tanks were estimated by contacting a vendor of these seals (Chicago Bridge and Iron Company).[4] The installed capital costs basically depend on the linear circumferential footage and thus on the diameter of the tank. The capital cost per foot of tank diameter tends to decrease as tank diameter increases. This is mainly because a significant fraction of the capital costs are fixed costs, which are independent of tank size. Therefore, the capital cost value per unit diameter tends to be smaller for larger tanks.

The fixed cost components of the capital costs of installing a secondary seal include (a) analyzing engineering aspects of the control equipment, (b) reviewing the tank measurements prior to finalizing the secondary seal, and (c) moving the project crew from one job site to the next. Since the cost analysis had to be done for 10 model tanks with different diameters, ETA Engineering developed a graphical relationship between the tank diameter and the installed capital costs per unit tank diameter. Cost data provided by the Chicago Bridge and Iron Company were used in developing this relationship, which is shown in Figure 8-3. The cost relationship presented in Figure 8-3 was based on the following assumptions:

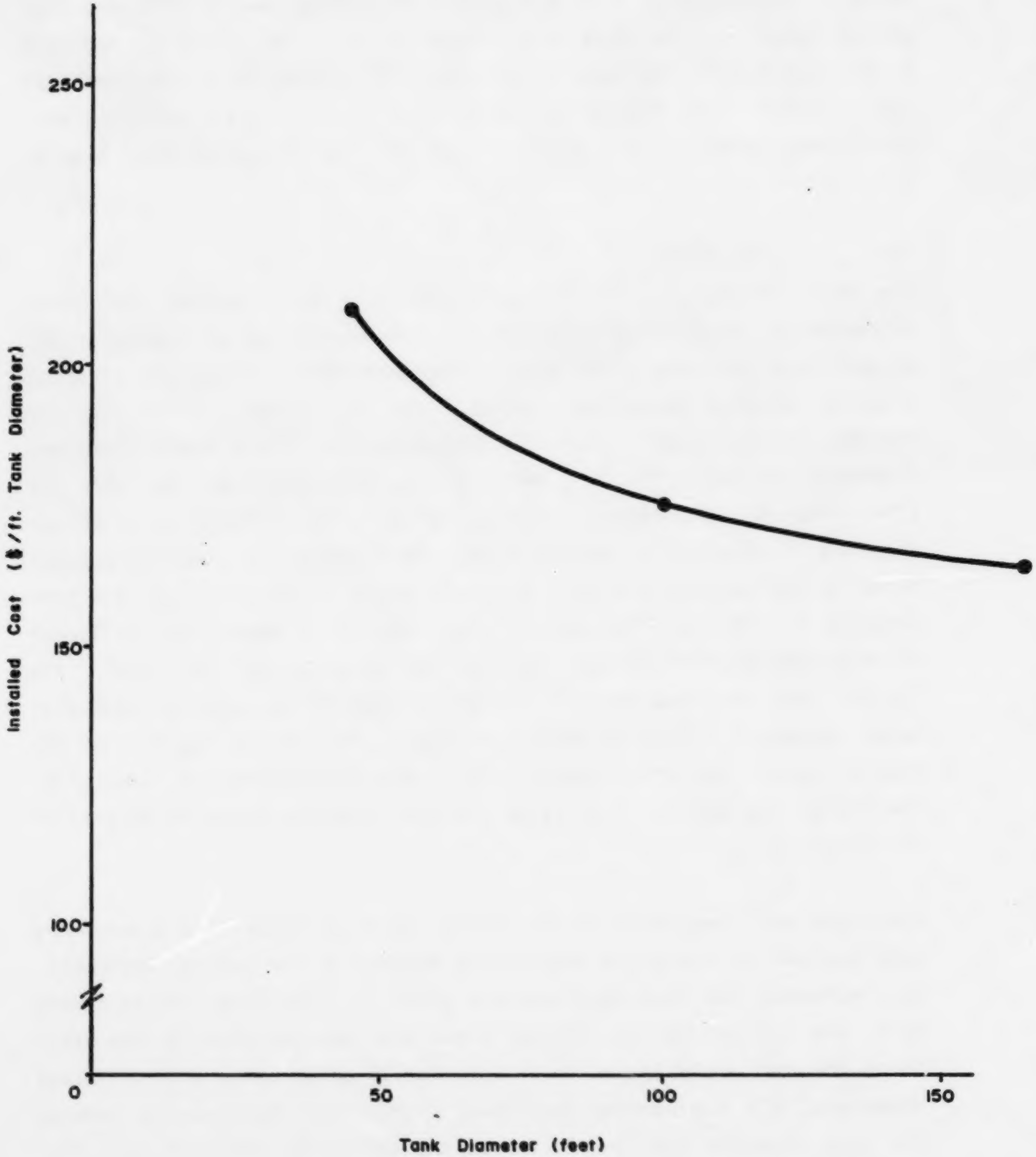


FIGURE 8-3 RELATIONSHIP BETWEEN TANK DIAMETER AND INSTALLED COST OF SECONDARY SEAL

a. Wage rates in the Cleveland locale were used to estimate the installation costs.

b. It was assumed that the tank roof has eight inches of rim space for installing the secondary seal.

c. It was assumed that a small angle would be attached to the existing rim of the tank so that the secondary seal could be attached with clips.

d. Finally, the installed cost estimates assume the retrofitting of a single tank per site. If a group of tanks are to be retrofitted with secondary seals at one particular site, the installed cost value per tank would probably be reduced by 5 to 10 percent.

The cost relationship presented in Figure 8-3 was used to estimate the model tank costs and the total installed capital costs for all the affected tanks. These cost estimates are presented in Table 8-6 for affected gasoline storage tanks and in Table 8-7 for affected crude oil storage and naphtha storage tanks.

In addition to estimating the capital costs of installing secondary seals on affected external floating roof tanks, the cost incidence was also presented in terms of net annualized costs. The net annualized costs include the annual operating and maintenance costs and the fixed capital charges. Fixed capital charges consist of a capital recovery factor for depreciation and interest charges and a factor for insurance, taxes and administrative overheads (4 percent of capital costs). The capital recovery factor was estimated to be 17.7 percent of the capital costs based on 10 years useful equipment life and a 12 percent interest rate. The annual operation and maintenance costs were estimated at 5 percent of the installed capital cost plus an annual inspection charge of $200 per tank. The product credit considered in the net annualized costs was estimated by using the following product values based on the

TABLE 8-6. CAPITAL COST ESTIMATES FOR INSTALLING SECONDARY SEALS ON AFFECTED GASOLINE STORAGE TANKS

Model Tank	Diameter (feet)	Number of Storage Tanks Represented	Installed Capital Cost Per Tank (10^3 $/tank)	Total Installed Capital Costs ($10^3$$)
#1	45	74	9.7	718
#2	78	67	14.7	985
#3	100	25	18.0	450
#4	119	40	20.9	836
#5	123	13	21.5	280
#6	136	12	23.5	282
#7	148	31	25.5	791
#8	159	1	27.0	27
		263		4,369

TABLE 8-7. CAPITAL COST ESTIMATES FOR INSTALLING SECONDARY SEALS ON AFFECTED NAPHTHA AND CRUDE OIL STORAGE TANKS

	Crude Oil	Naphtha	Total
Model tank capacity (10^3 gallons)	3,275	3,051	-
Model tank diameter (feet)	118	1,141	-
Number of storage tanks represented	12	4	16
Model tank installed capital cost (10^3 \$)	20.8	20.2	-
Total installed capital costs (10^3 \$)	250	81	331

data in the Wall Street Journal on the cash prices of commodities as of January 1981:

Gasoline	-	\$0.98/gallon
Crude oil	-	\$32.0/barrel
Naphtha	-	\$0.98/gallon

A summary of the control cost estimates for all the affected tanks is given in Table 8-8. The total installed capital costs for all the 279 affected storage tanks were estimated to be approximately \$4.7 million. The corresponding net annualized costs after considering the annual petroleum savings were estimated to be approximately \$745,000. The Table also gives a value for the cost-effectiveness of control in terms of dollars per ton of reduction. Based on a total reduction of 1,812 tons of VOC per year (1,753 tons/yr for gasoline storage tanks and 59 tons/yr for crude oil and naphtha storage tanks), the cost-effectiveness of control was estimated to be \$411 per ton of reduction in emissions.

TABLE 8-8. CONTROL COST SUMMARY FOR EXTERNAL FLOATING ROOF PETROLEUM STORAGE TANKS

	Gasoline	Crude Oil	Naphtha	Total
Number of affected tanks	263	12	4	279
Installed capital costs (10^3 $)	4,369	250	81	4,700
Annualized capital charges (10^3 $)[a]	948	54	18	1,020
Annual maintenance costs (10^3 $)[b]	271	15	5	291
Annual petroleum savings (10^3 $)[c]	(547)	(12)	(7)	(566)
Net annualized costs (10^3 $)	672	57	16	745
Cost-effectiveness ($ per ton of reduction)	383	1,540	727	411

[a] Based on a capital charge factor of 21.1 percent of installed capital costs for interest, depreciation, taxes, and insurance (12 percent interest rate and seal replacement life of 10 years).

[b] Five percent of installed capital cost plus annual inspection charge of $200 per tank (source: Reference 5).

[c] Based on a reduction of 1,753 tons/yr in gasoline emissions and 59 tons/yr in crude oil/naphtha emissions. The credit was calculated at $0.98/gallon for gasoline and $32/barrel for crude oil. Average densities were assumed to be 6.2 lbs/gallon and 7.2 lbs/gallon for gasoline and crude oil, respectively.[6]

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9.0 DRY CLEANERS

9.1 INTRODUCTION

The dry cleaning industry provides both cleaning and rental services for apparel and other fine goods. The industry is divided into coin-operated, commercial, and industrial segments, based on the types of services offered. Coin-operated dry cleaning facilities are usually part of a laundromat and operate on either an independent or franchise basis. They provide low cost, self-service dry cleaning without pressing, spotting, or other associated services. Commercial dry cleaning plants are the most familiar type of facilities, offering the normal services associated with cleaning and preparing soiled apparel and other items for re-use. They include small, independent neighborhood shops, franchised dry cleaners, and specialty cleaners. Industrial dry cleaners are the largest dry cleaning plants, predominantly supplying cleaning and rental services for uniforms and treated dust control items to business, industrial, or institutional customers.

Dry cleaning is essentially a waterless process in which items are cleaned with a solvent rather than with detergent and water. The solvents are catagorized as either petroleum or synthetic solvents. The RACT regulation applies to certain dry cleaning plants that utilize the synthetic solvent perchloroethylene (perc), which is considered a volatile organic compound. Based on 1976 Bureau of Census data and estimates from industry spokesmen, the nationwide numbers of commerical and industrial perc dry cleaning establishments are 15,060 and 239, respectively.[1] National perc emissions are about 135,580 tons for commercial and 14,990 tons for industrial dry cleaning plants.[2]

Ohio's RACT regulation applies to perc dry cleaning establishments located in the 18 designated urbanized counties and those plants located elsewhere in the state which have potential annual atmospheric emissions of perc vapor exceeding 100 tons. Exempt from the regulation are: dry cleaning plants that do not use perc; coin-operated dry cleaning facilities; and facilities at which it can be demonstrated to the Ohio EPA that a carbon adsorber cannot be installed due to insufficient steam capacity and/or inadequate space. The estimate of affected facilities was not reduced due to the latter exemption possibility since it is expected that very few establishments will seek an exemption for this reason.

The regulation, presented in Appendix B, requires that:

- Dryer exhaust be vented through a carbon adsorber that emits no more than 100 parts per million of perc by volume;
- Dryer exhaust be vented through a device which is, in the judgment of the OEPA, at least as effective in controlling perc emissions as the above-mentioned carbon adsorber;
- Waste from any diatomaceous earth filter used to filter perc cannot contain more than 25 percent of perc by weight;
- Waste from any solvent still used to distill perc cannot contain more than 60 percent of perc by weight;
- Any disposable filter cartridge used to filter perc be drained in its filter housing at least 24 hours; and
- Any equipment leaking perc liquid not be operated until the leak is repaired.

9.2 CHARACTERIZATION OF AFFECTED FACILITIES

9.2.1 Estimated Number of Ohio Commercial and Industrial Dry Cleaning Plants

The total number of commercial and industrial dry cleaning establishments in Ohio was taken from data contained in the Bureau of the Census publication County Business Patterns 1978-Ohio. For the entire state, a total of 871 plants is listed under Standard Industrial Classification (SIC) code 7216, titled Dry Cleaning Plants, Except Rugcleaning. These establishments include small independent neighborhood shops, franchised shops, and specialty cleaners which clean leather and other fine goods.

The same census publication lists 52 establishments under SIC code 7218, Industrial Launderers. The definition of SIC code 7218 is as follows:

> Establishments primarily engaged in supplying laundered or dry-cleaned work uniforms; laundered wiping towels; safety equipment (gloves, flame resistant clothing, etc.); dust control items, such as treated mats or rugs, mops, dust tool covers and clothes and other selected items to industrial or commercial users. These items may belong to the industrial launderers and be supplied to users on a rental basis, or they may be the customer's own goods. Establishments included in this industry may or may not operate their own laundry or drycleaning facilities.[3]

Ohio regulations apply to all perchloroethylene (perc) dry cleaning establishments, commercial and industrial, located in the eighteen urbanized counties, and those establishments outside these counties that have a potential to emit at least 100 tons per year of perc vapors. SIC code 7216 facilities located in the eighteen Ohio counties are summarized in Table 9-1. Four of the eighteen counties, Clermont, Greene, Medina, and Wood each have less than fifty paid employees in the commercial dry cleaning industry. For the purposes of this study, it is assumed that these counties each have 49 paid employees in the commercial dry cleaning industry. It is also assumed that each of the four counties have seven commercial dry cleaning establishments, the same number as reported for Portage and Warren counties, which have between 50 and 75 paid employees in this industry category. Therefore, it is estimated that there are 5,425 paid employees working in 681 commerical dry cleaning plants in the eighteen Ohio counties.

TABLE 9-1

SIC CODE 7216-DRY CLEANING FACILITIES IN EIGHTEEN OHIO COUNTIES

COUNTY	NUMBER OF EMPLOYEES	ANNUAL PAYROLL (thousands of dollars)	NUMBER OF ESTABLISHMENTS BY EMPLOYMENT SIZE CLASS 1-4	5-9	10-19	20-49	50-99	100-249	TOTAL
Butler	202	770	7	5	2	1	1	-	16
Clermont[a]	49[b]	-	-	-	-	-	-	-	7[c]
Cuyahoga	1216	7176	79	35	24	10	2	-	150
Franklin	818	5024	32	35	21	5	1	-	94
Greene[a]	49[b]	-	-	-	-	-	-	-	7[c]
Hamilton	755	4065	56	29	14	5	1	-	105
Lake	114	466	7	6	3	1	-	-	17
Lorain	147	785	9	6	3	2	-	-	20
Lucas	381	1922	18	6	13	5	-	-	42
Mahoning	232	1360	18	3	5	3	-	-	29
Medina[a]	49[b]	-	-	-	-	-	-	-	7[c]
Montgomery	498	2976	16	23	7	5	1	-	52
Portage	74	436	2	3	-	2	-	-	7
Stark	264	1362	14	14	6	2	-	-	36
Summit	388	1957	32	15	13	2	-	-	62
Trumbull	83	354	12	2	1	1	-	-	16
Warren	57	276	4	1	1	1	-	-	7
Wood[a]	49[b]	-	-	-	-	-	-	-	7[c]
Total	5425								681

NOTE: Data obtained from County Business Patterns-Ohio, 1978.

[a] Data unavailable, indicating less than 50 salaried employees in the county.

[b] Number of employees assumed to be 49.

[c] Total number of establishments assumed to be 7, equaling that of either Portage or Warren county.

In 1978, self-employed persons comprised about 8 percent of the nation's paid civilian employment.[4] There may be commercial dry cleaning establishments in Ohio, not reported in the county business patterns data, that are totally owned and operated by self-employed persons on a family-owned or partnership basis. It is assumed that the number of these establishments is negligible compared to the number of establishments having paid employees. Therefore, cost estimates presented in this study will be based on commercial dry cleaners having one or more paid employees.

Table 9-2 summarizes the location and size of 41 of the 52 Ohio industrial laundering facilities. The remaining 11 establishments have location and employment characteristics such that no county has at least 50 paid workers in the industrial laundering industry. Thirty-eight of the 41 industrial launderers are located in one of the 18 urban counties.

The definition of SIC code 7218 states that industrial laundering plants may or may not have drycleaning equipment. In 1979, the Institute of Industrial Launderers estimated that 40 to 45 percent of industrial laundering plants had drycleaning equipment.[1] In this study, it is assumed that 42.5 percent, or 22 of the Ohio industrial laundering plants also perform drycleaning. It is further assumed that the industrial laundering and drycleaning operations are conducted by establishments having at least one paid employee. Therefore, cost estimates presented in this study will be based on the estimated 22 industrial drycleaning facilities in the state of Ohio. Since the number of laundering plant employees totally or partially involved in a facility's dry cleaning operation is highly variable, state wide employement in industrial dry cleaning is not estimated.

9.2.2 Estimated Number of Perchloroethylene Dry Cleaning Plants

There are an estimated 681 commercial dry cleaning plants in the 18 Ohio counties and an estimated 22 industrial laundering plants in the state which perform dry cleaning. In 1979, the International Fabricare

TABLE 9-2

SIC CODE 7218-INDUSTRIAL LAUNDERERS IN ALL OHIO COUNTIES

COUNTY	NUMBER OF EMPLOYEES	ANNUAL PAYROLL (thousands of dollars)	NUMBER OF ESTABLISHMENTS BY EMPLOYMENT SIZE CLASS			TOTAL
			1-19	20-99	> 100	
Allen[a]	b	b	-	1	-	1
Auglaize[a]	b	b	-	1	-	1
Clark[a]	b	b	-	1	-	1
Cuyahoga	647	6953	2	3	2	7
Franklin	b	b	1	1	2	4
Hamilton	401	3423	5	-	2	7
Lorain	b	b	-	-	1	1
Lucas	313	2975	5	2	1	8
Mahoning	b	b	-	1	-	1
Montgomery	b	b	1	3	2	6
Stark	91	923	-	3	-	3
Summit	b	b	-	-	1	1
Total						41

NOTE: Data obtained from County Business Patterns-Ohio, 1978.

[a] Not included among the 18 urban counties.

[b] Information withheld by the Census Bureau to avoid disclosure of operations of individual establishments.

Institute (IFI) estimated that approximately 73 percent of the nation's commercial dry cleaning establishments use perc. In the same year, the Institute of Industrial Launderers (IIL) estimated that 50 percent of the industrial launderies providing dry cleaning services utilize perc.[1] The IFI and IIL believe these estimates are still representative of their respective industries.[5,6]

The Ohio Cleaners Association (OCA), which is comprised of approximately 350 member establishments, has never maintained records of the type of solvent employed by its members.[7] In this study, therefore, it is assumed that the IFI and IIL's national estimates of the percentages of commercial and industrial dry cleaners using perc are representative of industry conditions in Ohio. Thus, the estimated number of commercial perc dry cleaners in the 18 Ohio counties is 497, while an estimated 11 industrial dry cleaning plants in Ohio use this cleaning agent.

9.2.3 Estimated Number of Plants Affected by Ohio's RACT Regulation

Estimates of uncontrolled and controlled perc emissions from dry cleaning plants are based on the weight of clothes processed and emission factors for the various steps in the dry cleaning and solvent recovery processes. Annual throughput of clothes and solvent mileage data were unavailable from our research. The Ohio Cleaners Association (OCA) readily admits that it has never attempted to keep records of perc emission control equipment in service or records of weight of clothes processed and solvent mileage of its member establishments.[7] Therefore, the number of dry cleaners outside the 18 counties affected by the regulation must be estimated from published ranges of annual clothes throughput and emission factors for "typical" dry cleaning operations.

Various ranges of annual clothes throughput are found in the literature for both commercial and industrial dry cleaning operations. In a 1979 study, commercial dry cleaners are reported to process a weight of clothes ranging from less than 9,000 to over 45,000 kg per year.[3] According to the IFI, annual clothes throughput varies from less than

23,000 to 113,000 kg.[1] Model commercial plant throughput data used in this study are within these ranges. For the industrial segment of the dry cleaning industry, estimates of annual throughput range from 240,000 to 700,000 kg.[2] Modeled Ohio industrial dry cleaning plant throughput is well within this range.

Sources of perc emissions include: dryer exhaust; cooked or uncooked filter muck; alternative drained or undrained filter cartridges; solvent still waste; and miscellaneous losses (primarily liquid leaks). Perc emission factors found in the literature for commercial or industrial dry cleaning plants also exhibit variability, as indicated in Table 9-3. The CTG document and Background Information Document (BID) for the proposed New Source Performance Standard (NSPS) state that "well operated" plants may lose about 3 to 23 kg of perc per 100 kg of clothes processed, with industry average loss estimates of either 10.6 to 12.0 kg of perc.[1,2] Both documents caution that these emission factors are for "well-operated plants". Apparently the well operated plant may or may not have a dryer exhaust vapor control system, but does have some capability for solvent recovery from filtered materials. Another U.S. EPA publication, Compilation of Air Pollutant Emission Factors - AP42, presents a range of perc loss from a "typical" dry cleaning plant from 4.4 to 25.1 kg per 100 kg of clothes cleaned.[8]

In this study, the number of Ohio dry cleaning plants capable of emitting 100 tons of perc annually are estimated from maximum clothes throughput and perc emission rate data obtained from the aforementioned publications. The resulting annual perc emission estimates, summarized in Table 9-4, indicate that it is extremely unlikely that a commercial dry cleaning plant could emit 100 tons of perc on an annual basis. However, the 100 ton per year emission figure could be achieved at an industrial dry cleaning operation. Therefore, it will be assumed that the set of perc dry cleaning plants affected by Ohio's RACT regulation consists of:

TABLE 9-3

PERCHLOROETHYLENE EMISSION FACTORS FROM COMMERCIAL OR INDUSTRIAL DRY CLEANING ESTABLISHMENTS

EMISSION SOURCE	EMISSION FACTORS (KG/100 KG OF CLOTHING) FOR WELL[a] OPERATED PLANTS	FOR[b] TYPICAL PLANTS
Dryer Exhaust:		
without carbon adsorber	7.0	8.0
with carbon adsorber	0.3	0.3
Retention in Filter Muck:		
without cooking or draining	14.0	14.0
rigid tube filter with muck cooker	1.6	1.6
regenerative filter with muck cooker	1.0	1.0
Retention in Drained Cartridge Filters	0.6	1.1
Retention in Still Residue	1.0[c]	1.6[d]
Miscellaneous Leaks	1.0	1.5
Total Potential Emissions	2.9[e]-23[f]	4.4[e]-25.1[f]

[a] References 1 and 2.

[b] Reference 8.

[c] No EPA test data. Value assumed by EPA.

[d] Based on IFI estimate.

[e] Assuming carbon adsorber unit and solvent recovery from filtered materials.

[f] Assuming no carbon adsorber unit and uncooked filter muck.

TABLE 9-4

MAXIMUM ESTIMATED PERCHLOROETHYLENE EMISSIONS FROM TYPICAL COMMERCIAL AND INDUSTRIAL DRY CLEANING PLANTS

TYPE OF PLANT	MAXIMUM CLOTHES[a] THROUGHPUT (kg/yr)	PERC EMISSION[b] (kg/100 kg of clothes)	ESTIMATED MAXIMUM PERC EMISSIONS	
			(kg/yr)	(tons/yr)
Commercial	113,000	25.1	28363.0	31.3
Industrial	700,000	25.1	175700.0	193.7

[a] From model plants.

[b] Worst case perc emissions from Table 9-3.

- All commercial perc dry cleaners in the 18 urban counties; and
- All industrial perc dry cleaners located in the state.

9.2.4 Model Plant Formulation

Model plants are used as a basis for estimating the economic impact of Ohio's RACT regulations on existing commercial and industrial perc dry cleaning plants. Model plant parameters summarized in Table 9-5 are based upon models already developed in previous U.S. EPA studies of the perc dry cleaning industry.[1,2] In the commercial sector of the industry, about 25 percent of the machines are dry-to-dry type, and the remainder are transfer machines. Two machine sizes, 11 and 23 kg (25 and 50 pound capacity), are considered to be representative of the sizes of dryers generally found in the commercial plants. The representative industrial dryer's 113 kg capacity is based on information obtained from the Institute of Industrial Launderers.[1]

Annual throughput data are not compiled at many commercial and industrial dry cleaning plants. Therefore, estimates of the weight of materials dry cleaned annually at these facilities must be incorporated as model plant parameters. Estimated throughput data used in this study are model plant parameters utilized in the U.S. EPA's CTG document.[2]

9.3 ALTERNATIVE CONTROL MEASURES

Dry cleaning is a process in which clothes are primarily cleaned with an organic solvent rather than with soap and water. A small amount of water and detergent may be added to the solvent to remove water soluble materials from the clothes. The principal steps in the process are analagous to those of laundering in water. Figure 9-1 is a schematic of a perc dry cleaning process. First, clothes and solvent are agitated in a washer. After washing is completed, the clothes are spun as in a washer spun cycle to remove solvent. This is called the extraction step. After extraction, solvent is filtered and distilled to remove impurities

TABLE 9-5

MODEL PLANT PARAMETERS FOR OHIO COMMERCIAL AND INDUSTRIAL PERCHLOROETHYLENE DRY CLEANING PLANTS

PARAMETER	COMMERCIAL PLANTS		INDUSTRIAL PLANTS
Machine Capacity (kg/load)	11	23	113
Machines per Plant	1	1	1
Annual Washer Loads	2210	2113	5007
Annual Operation (days/yr)	250	250	250
Annual Throughput (kg/yr)	24310	48600	565790

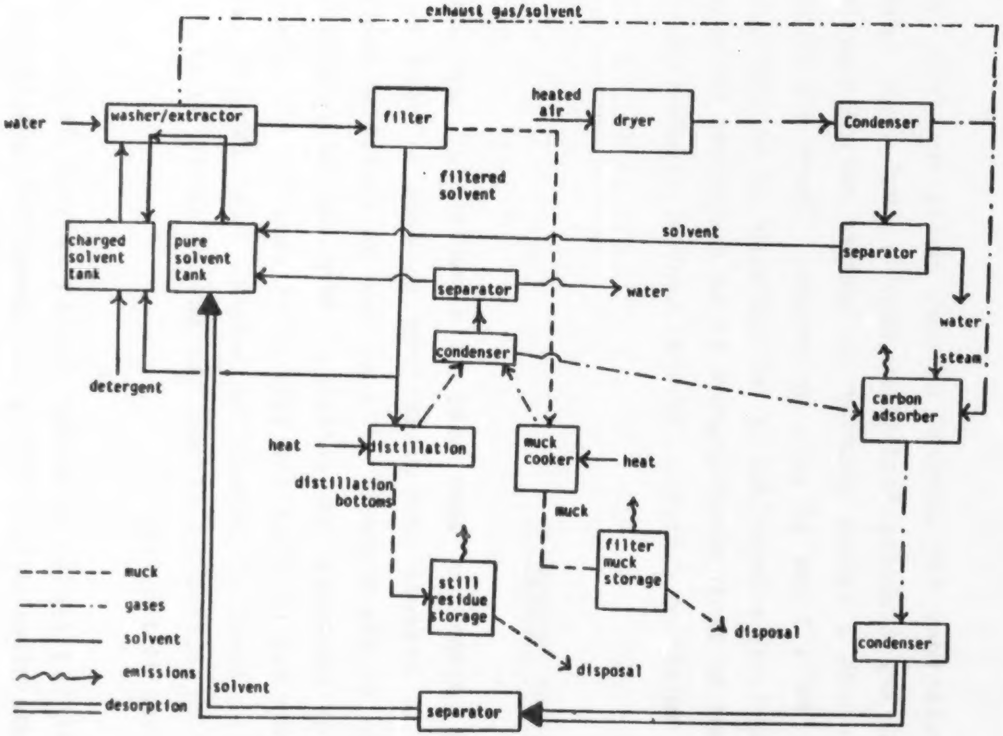
exhaust gas/solvent
water
washer/extractor
filter
heated air
dryer
Condenser
filtered solvent
charged solvent tank
pure solvent tank
solvent
separator
separator
water
condenser
water
steam
detergent
carbon adsorber
heat
distillation
muck cooker
heat
distillation bottoms
muck
filter muck storage
still residue storage
disposal
disposal
condenser
separator
solvent
muck
gases
solvent
emissions
desorption

FIGURE 9-1

PERCHLOROETHYLENE DRY CLEANING PLANT FLOW DIAGRAM before being returned to the system. The filtered solids (muck) contain solvent, some of which can be removed and returned to the system. After solvent wash and extraction, the clothes are tumbled dry. During the drying cycle, much of the evaporated solvent can be recovered and returned to the system. Remaining solvent in the clothes is reduced by venting air through the clothes. This final step is called aeration or deodorization.

Ohio regulations for control of perc emissions from commercial and industrial dry cleaning facilities specify that dryer exhaust is to be vented through a carbon adsorber or another device capable of limiting emissions to 100 ppm of perc by volume. There are several alternate control devices, categorized as refrigeration or scrubbing systems, which are claimed by their manufacturers to be equivalent to carbon adsorption for perc emissions control. Several control alternatives are discussed below.

9.3.1 Carbon Adsorption

Activated carbon has been used in a variety of applications for the removal of organic compounds from gaseous streams by adsorption. Adsorption is the property of a surface to retain molecules of a fluid which have contacted the surface. Perc can be retained by activated carbon very easily since the adsorptive capacity of carbon with respect to perc is about 20 percent by weight. For example, a 100 kilogram (kg) bed of activated carbon can adsorb about 20 kg of perc before regeneration is required.

In the drying cycle, a blower forces solvent-laden air through the carbon adsorption unit. A typical commercial adsorption unit has one carbon cannister which is usually desorbed daily. A large industrial adsorption unit may contain multiple canisters so that one carbon bed can be used while another is being regenerated. Desorption is accomplished by passing steam through the carbon bed. Vaporized solvent is picked up by the steam, recovered downstream in a condenser, separated from the water, and then returned to the perc storage tank.

For a dry cleaning operation involving the manual transfer of clothes from a washer to a dryer unit, the Occupational Safety and Health Administration (OSHA) requires that a current of fresh air be provided to reduce solvent vapor inhalation by the operator. The required ventilation may be provided by a fan which draws air through a duct at the dryer door lip or by venting directly through the dryer door. This solvent-laden airstream is then vented to the carbon adsorber. Floor vents may be installed around the dryers and next to perc storage tanks in order to collect fugitive emissions and vapors from solvent spills. These emissions can also be directed to the adsorber unit. Carbon adsorption can result in better than 96 percent emission reduction for all gas streams passed through the adsorber unit.[1]

The emission limitation of 100 ppm for the dryer exhaust from perc dry cleaning systems can easily be achieved by venting solvent-laden airstreams through a properly designed and operated activated carbon adsorption system. Factors which can interfere with maintaining compliance with the emission limitation include:

- Insufficient adsorptive capacity of the activated carbon bed due to defects on the adsorbing material;
- Leakage in the piping, adsorption unit cannister, or ductwork;
- Variations in humidity of the airstream to the adsorber unit;
- Adsorption of contaminants that may be present in the air stream during adsorption or in the steam used for desorption;
- Lint accumulation on the carbon particles; and
- Service life of the activated carbon, which is a function of the number of adsorption/desorption cycles.[1] While equipment vendors claim a 10 to 15 year service life for the activated carbon in similar applications service life may be as low as 3 to 5 years.[9]

9.3.2 Refrigeration Systems

Two St. Louis based firms, Spencer America Corporation and Kleen-Rite Incorporated, are manufacturers/distributors of refrigeration systems that are claimed to be capable of reducing perc emissions from the dryer exhaust to 100 ppm or less.

For the Spencer Resolver, solvent-laden air from the aeration phase of the cleaning cycle is ducted to a cold storage system which consists of a bed of stones and refrigerant coils. Solvent condenses and drips into a perc/water separator below the bed. In contrast to carbon adsorption systems, air leaving the bed of the refrigeration system is not vented to the atmosphere. Instead, the air is returned to the dryer unit.

The Kleen-Rite models KR II and KR III refrigeration systems condense solvent from perc-laden air streams during both the drying and aeration phases of the cleaning cycle. These airstreams are passed through finned-tube refrigerated condensers. Condensed solvent drips into a perc/ water separator below the condensers. A portion of the cold air exiting the condensers is recirculated, while the remainder is vented to the atmosphere.

There are perc emission points that would normally be ducted to a carbon adsorption unit that would not be controlled by either manufacturer's refrigeration system. For example, floor vents that would be ducted to a carbon adsorber could not be ducted to a refrigeration system without adversely affecting system efficiency. During dry cleaning operations involving the hand transfer of clothes from the washer to the dryer unit, perc vapors are normally drawn into the dryer unit and then to the carbon adsorber. The refrigeration systems would be operational only during the drying and/or aeration phases of the cleaning cycle, and not during the physical transfer phase.

9.3.3 Scrubber System

Another alternative to carbon adsorption is the Solvation (registered trademark) unit which was first patented in England and is sold by the Diversitron Corporation in the United States. In 1979, this country's first Solvation unit was installed. The Solvation unit operates during the aeration phase of the dry cleaning process. Solvent-laden air passes through a scrubber consisting of screens and baffles submerged in water. Air bubbles are formed and mass transfer of perc occurs from the bubbles to the water. The primary force for mass transfer of perc is claimed to be the formation of a perc/water azeotrope. An azeotrope is a liquid mixture having a constant boiling point and capable of distilling off in a fixed ratio without decomposition. The solvent-rich azeotropic vapor stream is passed over cooling coils where perc condensation occurs. Separation of perc and water takes place in the unit's water separator. The vapor stream, now having a relatively low perc concentration, is returned to the Solvation Tank for renewed azeotropic conditioning. Like the refrigeration systems, the Solvation unit cannot be used to control perc emissions from floor vents or from the physical transfer of clothes to the cleaning system's dryer unit. The manufacturer claims that operation of the Solvation unit increases the average weight of clothes cleaned per gallon of perc by at least 100 percent.[10]

9.3.4 Control of Perc Emissions From Sources Besides Dryers

The Ohio RACT II regulation for control of solvent emissions from perc dry cleaning facilities addresses emission points other than dryer exhaust. The regulation states that:

- Waste from diatomaceous earth filters used to filter perc may not contain more than 25 percent by weight of perc;
- Disposable filter cartridges used to filter perc must be drained in their filter housing for at least 24 hours before being discarded;
- Waste from solvent stills used to distill perc may not contain more than 60 percent by weight of perc; and
- Equipment leaking perc liquid cannot be operated until the leak is repaired.

Techniques for control of perc emissions from these emission points are discussed in the following paragraphs.

Some of the soils removed from fabrics during the dry cleaning process are not soluble and must be filtered from the solvent. Some filters may contain activated carbon. The filter muck (diatomaceous earth, carbon, lint, detergent) also contains solvent which is recovered in some perc plants by cooking solvent out of filtered materials. One alternative is the use of cartridge filters which the regulations state must be drained in their housing for at least 24 hours prior to disposal. The International Fabricare Institute (IFI) has suggested to the U.S. EPA that cartridge draining may also be accomplished in another properly sealed container. This is particularly beneficial for plants having only one cartridge housing unit.[5] Another alternative to muck cooking or cartridge draining is solvent recovery offsite by a solvent disposal vendor.

In addition to insoluble residue removed by filtration, a buildup of soluble residue (oils, fats, and greases) occurs in the solvent. These are eliminated from the solvent by distillation. In some perc plants, the distillation unit is used to separate solvent from both soluble and insoluble residue. Solvent losses from distillation bottom disposal can be reduced in "oil cookers" to levels below 1 kg per 100 kg of clothes cleaned if the distillation unit and oil cooker are properly operated and not prematurely shutdown.[2]

The state's regulations require repair of liquid perc leaks prior to resumption of dry cleaning operations. Liquid leaks are characterized by a brown residue that can be detected during an equipment inspection. The following inspection checklist can be used to facilitate liquid perc leak detection.[2]

Liquid leakage areas include:

- Hose connections, unions, couplings and valves;
- Machine door gasket and seating;
- Filter head gasket and seating;
- Pumps;
- Base tanks and storage containers;
- Water separators (lost in water due to poor separation);
- Filter sludge recovery (lost in sludge by improper recovery);
- Distillation unit;
- Divertor valves;
- Saturated lint from lint basket; and
- Cartidge filters.

9.3.5 Estimated Annual Perchloroethylene Emissions From Affected Plants Before and After Implementation of RACT

Based on estimates developed in previous subsections, approximately 497 commercial and 11 industrial perc dry cleaning facilities in Ohio will be subjected to the state's regulation. The total decrease in perc emissions from affected facilities will in part depend on the types of perc emission control equipment already installed and utilized at these facilities and on the extent to which good housekeeping procedures are followed to further reduce emissions through prompt detection of liquid leaks.

Factors complicating the estimation of current perc emissions from plants affected by the RACT regulation are: (1) the degree of utilization and actual efficiency of installed carbon adsorber systems; (2) the lack of national or Ohio estimates of the number of affected plants equipped with refrigeration or scrubber systems in lieu of carbon adsorbers; and (3) the fact that while these comparatively new control technologies may be equivalent or superior to carbon adsorbers, their performance has not been officially accepted as such by either the United States or Ohio EPAs. It is assumed that national estimates of facilities equipped with carbon adsorbers are representative of the percentages of

Ohio plants affected by the RACT regulation which are also equipped with dryer exhaust perc emission control devices. Solvent emissions from dryer exhaust are already being controlled at approximately 35 percent of the nation's commercial and 50 percent of the industrial perc dry cleaning plants.[2] Therefore, the estimated number of commercial plants in the 18 counties having carbon adsorbers is 174, while an estimated five industrial perc dry cleaners in the state have this control equipment. It is also assumed that the adsorbers installed at these plants are capable of routinely meeting the emission limitations imposed by the Ohio regulations.

From the data presented in Table 9-3, it is evident that the two greatest sources of perc vapor emissions are the dryer exhaust and the filter muck or filter cartridges. No national or state statistics are available regarding the number of dry cleaning plants equipped to recover solvent from either filter muck or cartridges. However, a well-run commercial or industrial plant will have a muck cooker.[1] Cartridge filters, originally introduced in the coin-operated segment of the dry cleaning industry, are also increasing in use at commercial plants.[2] It is possible that a dry cleaning establishment may have a muck ooker or equipment to recover solvent from cartridge filters, while not having equipment to recover solvent from dryer exhaust. The opposite situation may also exist. For the purposes of estimating perc emissions from establishments affected by the regulation, it is assumed that only those plants already equipped with dryer exhaust vapor control devices also have equipment to recover solvent from materials trapped by filters.

Losses associated with poor maintenance of dry cleaning equipment are difficult to quantify.[2] Fugitive emission points include leaks from valves, flanges, seals, etc. There are two types of perc losses (liquid and vapor) from miscellaneous point and fugitive emission sources. One solvent manufacturer estimates that a leak of one drip per second is equivalent to about 4 litres of perc loss per day.[2] Vapor leaks usually occur at evaporative points and tears in ductwork, and can be detected by smell or application of soap and water to suspect areas.

These assumptions resulted in average values of emission rates being utilized in calculations concerning these items. The figures used in estimating controlled emissions after the implementation of RACT are shown in Table 9-6 and are mainly the result of controlling dryer emissions.

9.4 COST ANALYSIS

The costs of controlling VOC emissions from the affected dry cleaning establishments were estimated by formulating three model plants to represent the varying facilities in Ohio. Technical parameters of these model plants are shown in Tables 9-5 and 9-6. The capital costs of purchasing and installing carbon adsorbers and the annual cost of operating such equipment were estimated by contacting four vendors to the dry cleaning industry (VIC, Hoyt, Diversitron, Kleen-Rite). The costs estimated for the model plants are presented in Table 9-7.

Annual operation and maintenance costs were estimated from discussions with the previously mentioned vendors. Operating costs include the costs of electricity, water, and boiler fuel. Electricity is consumed in powering the fan which draws solvent-laden air over the carbon bed during the adsorption cycle and provides airflow to dry the bed following desorption. Recommended desorption time is typically one hour. For commercial-sized carbon adsorption units, several hundred gallons of water must be heated and then utilized to steam strip the carbon bed. The value of perc used in this study was \$3.85 per gallon or \$0.63 per kilogram. The estimates of perc cost obtained from various sources ranged from a low of \$3.50 per gallon[11] to as high as \$4.15 per gallon.[12] The value assumed applicable in Ohio is approximately the center of this range.

The calculations of cost effectiveness per kilogram of recovered solvent were performed for each of the model plants since the effectiveness of the carbon adsorber perc recovery system varied for each size of plant, becoming more cost effective with increasing plant size. The overall

TABLE 9-6

ESTIMATED PERCHLOROETHYLENE EMISSIONS FROM DRY CLEANING PLANTS AFFECTED BY THE OHIO RACT REGULATION

	SMALL COMMERCIAL PLANT	LARGE COMMERCIAL PLANT	INDUSTRIAL PLANT
Annual Clothes Throughput (kg/yr)	24,310	48,600	565,790
Uncontrolled Emission Rate* (kg/100 kg clothes)	12	12	12
Controlled Emission Rate* (kg/100 kg clothes)	5	5	5
Emission Reduction (kg/yr)	1,702	3,402	39,605

*Reference 2.

TABLE 9-7

COSTS FOR CARBON ADSORPTION FOR PERCHLOROETHYLENE SOLVENT MODEL PLANTS

UNIT SIZE (kg)	11	23	113
PLANT TYPE	Commercial	Commercial	Industrial
Model Existing Facilities			
Installed capital cost	$4,760	$5,960	$13,500
Annual Operating Costs	$1,200	$1,300	$ 1,500
Annualized capital charges[a]	$ 957	$1,198	$ 2,714
Total annual costs	$2,157	$2,498	$ 4,214
Annual credit from perc recovery[b] @ $.63/kg	$1,072	$2,143	$24,951
Cost effectiveness			
($/kg removed)	0.64	0.10	(0.52)
($/ton removed)	578.36	94.67	(475.00)

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[a] Based on a capital charge factor of 20.1 percent of installed capital costs for interest, depreciation, taxes and insurance (12 percent interest rate and equipment life of 12 years).

[b] Based on the emission reductions shown in Table 9-6.

cost effectiveness for the entire industry of affected facilities is provided in Table 9-8. Emission reductions realized by performing proper operating techniques as applied to existing equipment were not included in the cost analysis since it is expected that plant operators will apply these techniques on their own accord as they learn the cost advantages of doing so. The controlled and uncontrolled emission rates demonstrating the effect of applying air pollution control techniques required by the Ohio regulations on the model plants were taken from the CTG document, and were intended to show average emission reductions available at the model plants, and not the actual total emissions of any one plant.

TABLE 9-8

CONTROL COST SUMMARY FOR CARBON ADSORPTION PERCHLOROETHYLENE SOLVENT PLANTS[a]

	SMALL COMMERCIAL PLANT	LARGE COMMERCIAL PLANT	INDUSTRIAL PLANT	TOTAL
Number of Affected Facilities	162	161	6	329
Installed Capital Costs ($1,000)	771.12	959.56	81.00	1811.68
Annualized Capital Charges ($1,000)	155.04	192.88	16.28	364.20
Annual Operating Costs ($1,000)	194.40	209.30	9.00	412.70
Annual Perc Recovery Credit ($1,000)	173.66	345.02	149.71	668.39
Net Annualized Costs ($1,000)	175.78	57.16	(124.43)[b]	108.51
Total Annual Emission Reduction (10^3 kg)	275.72	547.72	237.63	1061.08
Cost Effectiveness ($/kg of reduction)	0.64	0.10	(0.52)[b]	0.10

[a] Based on figures provided for model plants in Tables 9-6 and 9-7.

[b] Parentheses indicate a net savings.

9.5 REFERENCES

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10.0 SECONDARY ECONOMIC IMPACTS OF COMPLIANCE

10.1 Classification of Industries

The impact of compliance costs on Ohio industry is shown through the development of several economic indices. To determine these indices, it was necessary to first assign the industries considered in this study to industrial source categories. Each industry was assigned to a category according to its Standard Industrial Classification (SIC) code, as shown in Table 10-1. The use of SIC codes facilitates the development of economic impact indices because most of the economic data for the industrial/commercial sector is classified according to these codes.

10.2 Methodology for Data Collection

The industrial parameters of each SIC assigned to the industrial source categories are presented in Table 10-2. The table indicates the relative importance of each SIC within the assigned category. The table also shows the relative size of each industry as represented by number of firms, number of employees, [illegible], value added, capital expenditures, material cost, and payroll.

In Table 10-2, the term "value added" is a measure of manufacturing activity derived by subtracting the cost of materials, supplies, containers, fuel, electricity, and contract work from the value of shipments. The result of this computation is adjusted by the addition of value added by merchandising operations (difference between sales value and the cost of merchandise sold without further manufacture or processing) plus the net change in inventories between the beginning and end of the year. Capital expenditures include expenditures for permanent additions and major alterations to manufacturing establishments, including machinery and equipment for which depreciation accounts are maintained. Excluded from capital expenditures are items leased from nonmanufacturing concerns, government-owned facilities operated under contract by private companies, items furnished to the manufacturer by communities and nonprofit organizations, expenditures for land, and current operatng expenses. Cost of materials refers to direct charges

TABLE 10-1. INDUSTRIAL SOURCE CATEGORY AND ASSOCIATED STANDARD INDUSTRIAL CLASSIFICATION

Industrial Source Category	Standard Industrial Classification (SIC)	
Petroleum Refineries	2911	Petroleum refining
Surface Coating of Miscellaneous Metal Parts	254	Partitions, shelving, lockers, and office and store fixtures
	33	Primary metal industries
	34	Fabricated metal products, except machinery and transportation equipment
	35	Machinery, except electrical
	36	Electrical and electronic machinery, equipment, and supplies
	37	Transportation equipment
	384	Surgical, medical, and dental instruments and supplies
	5085	Industrial supplies
Gasoline Tank Trucks	5171	Petroleum bulk stations and terminals
Synthesized Pharmaceutical Manufacturing	2833	Medicinal chemicals and botanical products
Rubber Tire Manufacturing	3011	Tires and inner tubes
Graphic Arts	2751	Commercial printing, letterpress, and screen
	2754	Commercial printing, gravure
External Floating Roof Tanks	2911	Petroleum refineries
	5171	Petroleum bulk stations and terminals
Dry Cleaning	7216	Dry cleaning plants, except rug cleaning
	7218	Industrial launderers

TABLE 10-2. COMPARATIVE PARAMETERS OF COMPONENT INDUSTRIES OF INDUSTRIAL SOURCE CATEGORIES

Industry	Establishments	Employees (thousands)	Sales (million $)	Value Added (million $)	Capital Expenditures (million $)	Material Cost (million $)	Payroll (million $)
PETROLEUM REFINERIES							
2911 petroleum refining	6^{a}	2.3	3,034.2	401.3	31.8	2,653.2	61.5
SURFACE COATING - MISCELLANEOUS METAL PARTS							
254 partitions, shelving, lockers	105	4.0	202.7	110.4	2.1	95.0	58.6
33 primary metal industries	659	142.6	13,281.0	5,505.7	389.6	7,799.2	2,548.6
34 fabricated metal products	2,376	164.5	11,035.8	5,398.6	318.8	5,701.4	2,483.3
35 machinery, except electrical	3,683	197.3	10,766.5	5,989.2	333.0	4,889.7	2,945.0
36 electrical & electronic machinery	647	110.0	6,624.3	3,654.0	185.0	3,060.3	1,496.8
37 transportation equipment	468	158.9	16,568.9	6,376.5	494.1	10,259.6	3,061.2
384 surgical, medical, and dental instruments	110	4.2	167.0	91.1	3.6	76.9	44.8
5085 industrial supplies	810^{c}	10.0^{c}	2,360.2^{c}	n.a.^{b}	n.a.	n.a.	149.0^{c}
GASOLINE TANK TRUCKS							
5171 petroleum bulk stations and terminals	50	5.2	6,188.0	456.6	93.2	3,015.2	110.1

TABLE 10-2. (Continued)

Industry	Establishments	Employees (thousands)	Sales (million $)	Value Added (million $)	Capital Expenditures (million $)	Material Cost (million $)	Payroll (million $)
PHARMACEUTICAL MANUFACTURERS							
2833 medicinal chemicals	2	n.a.[b]	397.9	52.0	15.4	345.9	n.a.[b]
RUBBER TIRE MANUFACTURERS							
3011 tires & inner tubes	5	6.2	651.1	294.7	27.1	388.6	159.6
GRAPHIC ARTS							
2751 commercial printing, letterpress & screen	268	8.7	375.3	194.0	20.5	180.7	127.5
2754 commercial printing, gravure	9	0.5	58.6	29.0	1.7	29.9	6.9
EXTERNAL FLOATING ROOF TANKS							
5171 petroleum bulk stations & terminals	44	4.4	2,740.0	n.a.	n.a.	n.a.	54.5
DRY CLEANING							
7216 dry cleaning plants	871[d]	6.7[d]	89.0[e]	n.a.	n.a.	n.a.	36.1[d]
7218 industrial launderers	52[d]	3.1[d]	80.3[e]	n.a.	n.a.	n.a.	29.8[d]

Sources: 1977 Census of Manufactures - Ohio, unless otherwise noted.

[a] Ohio EPA

[b] n.a. = not available

[c] 1977 Census of Wholesale Trade - Ohio

[d] 1978 County Business Patterns - Ohio

[e] 1977 Census of Service Industries - Ohio

paid or payable for items consumed or put into production, including freight charges and cost of materials or fuel consumed during manufacturing operations.

Most statistics are presented as 1977 values and were taken directly from the 1977 Census of Manufactures for Ohio. There are a few exceptions, and these are either noted in Table 10-2 or explained in the following section. Other sources used for collecting the industry statistics include (1) communications with the Ohio EPA, (2) the Annual Survey of Manufacturers, 1975-1976, (3) the 1977 Census of Wholesale Trade for Ohio, (4) the 1978 County Business Patterns for Ohio, and (5) the 1977 Census of Service Industries for Ohio. In some cases census data were not available. For instance, census data were withheld by certain industries to avoid disclosure and were unavailable for others because of the service nature of their business.

10.3 Industrial Statistics for Source Categories

Industrial parameters, estimated pollution control costs, and economic impact indices are presented for each individual industrial source category in Tables 10-3 through 10-10. These tables indicate what each industry would have to spend to comply with RACT II guidelines. The indices were derived by dividing either total or annualized control cost values by the appropriate parameter.

Several limitations to the computed economic indices should be reorganized. Whenever possible, the economic parameters for only the affected portion of the industry were included in Table 10-2. When such information could not be isolated, statistics for the industry as a whole were used. Although control costs are expressed in terms of 1981 dollars, economic statistics summarized in Table 10-2 and categorized as industrial parameters in Tables 10-3 through 10-10 are largely taken from 1977 census data. These data are the most recent available, as economic censuses are taken at 5-year intervals. No adjustments to these 1977 statistics were made to account for inflation. Although national inflation factors are available for SIC codes, their relevance

TABLE 10-3. ECONOMIC STATISTICS FOR PETROLEUM REFINING FACILITIES IN OHIO

INDUSTRIAL PARAMETERS	
Number of Firms (potentially affected)	6
Employment	2,300
Sales ($)	3,034,240,000
Value Added ($)	401,280,000
Capital Expenditure ($)	31,768,000
Material Cost ($)	2,653,200,000
Payroll ($)	61,490,000
CONTROL COSTS	
Number of Firms (actually affected)	6
Capital ($)	55,000
O & M ($)	(1,784,000)
Annualized Capital ($)	16,000
Total Annualized ($)	(1,768,000)
ECONOMIC IMPACT INDICES	
Capital Control Costs as a Percentage of Annual Capital Expenditure (%)	0.173
Total Annual Control Cost as a Percentage of Sales (%)	(0.058)
Total Annual Control Cost as a Percentage of Value Added (%)	(0.44)

Note: Parentheses enclosing dollar amounts indicate a net savings.

TABLE 10-4. ECONOMIC STATISTICS FOR MISCELLANEOUS METAL COATING FACILITIES IN OHIO

INDUSTRIAL PARAMETERS	
Number of Firms (potentially affected)	8,846
Employment	791,553
Sales ($)	61,006,400,000
Value Added ($)	27,125,500,000
Capital Expenditure ($)	1,726,200,000
Material Cost ($)	31,882,100,000
Payroll ($)	12,787,300,000
CONTROL COSTS	
Number of Firms (actually affected)	87
Capital ($)	14,100,000-232,050,000
O & M ($)	2,999,000- 24,558,000
Annualized Capital ($)	2,813,000- 50,256,000
Total Annualized ($)	5,814,000- 74,820,000
ECONOMIC IMPACT INDICES	
Capital Control Costs as a Percentage of Annual Capital Expenditure (%)	0.8 - 13.4
Total Annual Control Cost as a Percentage of Sales (%)	0.01 - 0.123
Total Annual Control Cost as a Percentage of Value Added (%)	0.02 - 0.276

TABLE 10-5. ECONOMIC STATISTICS FOR MISCELLANEOUS METAL COATING FACILITIES IN OHIO BY SIC CODE

	SIC 254	SIC 33	SIC 34	SIC 35	SIC 36	SIC 37	SIC 384	SIC 5085
INDUSTRIAL PARAMETERS								
Number of Firms (potentially affected)	105	659	2,376	3,683	647	468	110	798
Employment	3,962	142,600	164,500	197,300	110,000	158,900	4,200	10,091
Sales ($ 10^6)	202.7	13,281.0	11,035.8	10,766.5	6,624.3	16,568.9	167.0	2,360.2
Value Added ($ 10^6)	110.4	5,505.7	5,398.6	5,989.2	3,654.0	6,376.5	91.1	-
Capital Expenditure ($ 10^6)	2.1	389.6	318.8	333.0	185.0	494.1	3.6	-
Material Cost ($ 10^6)	95.0	7,799.2	5,701.4	4,889.7	3,060.3	10,259.6	76.9	-
Payroll ($ 10^6)	58.6	2,548.6	2,483.3	2,945.0	1,496.8	3,061.2	44.8	149.0
CONTROL COSTS								
Number of Firms (actually affected)	1	6	38	11	12	17	1	1
Capital ($ 10^6)	0.3	6.6	3.3-133.0	0.96-42.9	1.0-22.8	1.2-25.5	0.04-0.25	0.7
O & M ($ 10^6)	0.044	0.64	1.2-12.9	0.35-5.0	0.38-2.8	0.25-3.0	0.007-0.046	0.098
Annualized Capital ($ 10^6)	0.056	1.43	0.6-28.9	0.18-9.3	0.19-4.9	0.23-5.5	0.007-0.05	0.15
Total Annualized ($ 10^6)	0.1	2.07	1.8-41.8	0.53-14.3	0.57-7.7	0.48-8.5	0.014-0.1	0.25
ECONOMIC IMPACT INDICES								
Capital Control Costs as a Percentage of Annual Capital Expenditure (%)	14.3	1.7	1.0-41.7	0.29-12.9	0.54-12.3	0.24-5.2	1.11-6.9	-
Total Annual Control Cost as a Percentage of Sales (%)	0.05	0.02	0.02-0.38	0.005-0.13	0.009-0.12	0.003-0.05	0.008-0.06	0.01
Total Annual Control Cost as a Percentage of Value Added (%)	0.09	0.04	0.03-0.8	0.009-0.24	0.016-0.21	0.007-0.13	0.015-0.11	-

TABLE 10-6. ECONOMIC STATISTICS FOR FACILITIES IN OHIO OPERATING GASOLINE TANK TRUCKS

INDUSTRIAL PARAMETERS	
Number of Firms (potentially affected)	50
Employment	5,225
Sales ($)	6,188,000,000
Value Added ($)	456,600,000
Capital Expenditure ($)	93,200,000
Material Cost ($)	3,015,200,000
Payroll ($)	110,100,000
CONTROL COSTS	
Number of Firms (actually affected)	50
Capital ($)	-
O & M ($)	387,000
Annualized Capital ($)	-
Total Annualized ($)	387,000
ECONOMIC IMPACT INDICES	
Capital Control Costs as a Percentage of Annual Capital Expenditure (%)	0
Total Annual Control Cost as a Percentage of Sales (%)	0.006
Total Annual Control Cost as a Percentage of Value Added (%)	0.09

Note: Dash indicates that information is not applicable in this case.

TABLE 10-7. ECONOMIC STATISTICS FOR PHARMACEUTICAL MANUFACTURING FACILITIES IN OHIO

INDUSTRIAL PARAMETERS	
Number of Firms (potentially affected)	2
Employment	n.a.
Sales ($)	397,916,000
Value Added ($)	51,995,000
Capital Expenditure ($)	15,376,000
Material Cost ($)	345,921,000
Payroll ($)	n.a.
CONTROL COSTS	
Number of Firms (actually affected)	2
Capital ($)	83,600
O & M ($)	12,500
Annualized Capital ($)	15,700
Total Annualized ($)	28,200
ECONOMIC IMPACT INDICES	
Capital Control Costs as a Percentage of Annual Capital Expenditure (%)	0.54
Total Annual Control Cost as a Percentage of Sales (%)	0.007
Total Annual Control Cost as a Percentage of Value Added (%)	0.054

Note: n.a. indicates that the information is not available.

TABLE 10-8. ECONOMIC STATISTICS FOR RUBBER TIRE MANUFACTURING FACILITIES IN OHIO

INDUSTRIAL PARAMETERS	
Number of Firms (potentially affected)	5
Employment	6,210
Sales ($)	651,100,000
Value Added ($)	294,700,000
Capital Expenditure ($)	27,100,000
Material Cost ($)	388,600,000
Payroll ($)	159,600,000
CONTROL COSTS	
Number of Firms (actually affected)	4
Capital ($)	1,014,000
O & M ($)	33,000
Annualized Capital ($)	243,000
Total Annualized ($)	276,000
ECONOMIC IMPACT INDICES	
Capital Control Costs as a Percentage of Annual Capital Expenditure (%)	3.74
Total Annual Control Cost as a Percentage of Sales (%)	0.042
Total Annual Control Cost as a Percentage of Value Added (%)	0.094

TABLE 10-9. ECONOMIC STATISTICS FOR ROTOGRAVURE AND FLEXOGRAPHIC PRINTING FACILITIES IN OHIO

INDUSTRIAL PARAMETERS	
Number of Firms (potentially affected)	277
Employment	9,223
Sales ($)	433,900,000
Value Added ($)	223,000,000
Capital Expenditure ($)	22,200,000
Material Cost ($)	210,600,000
Payroll ($)	134,400,000
CONTROL COSTS	
Number of Firms (actually affected)	16
Capital ($)	2,691,000
O & M ($)	4,576,000
Annualized Capital ($)	584,000
Total Annualized ($)	5,160,000
ECONOMIC IMPACT INDICES	
Capital Control Costs as a Percentage of Annual Capital Expenditure (%)	12.1
Total Annual Control Cost as a Percentage of Sales ($)	1.19
Total Annual Control Cost as a Percentage of Value Added ($)	2.3

TABLE 10-10. ECONOMIC STATISTICS FOR FACILITIES IN OHIO WITH EXTERNAL FLOATING ROOF STORAGE TANKS

INDUSTRIAL PARAMETERS	
Number of Firms (potentially affected)	44
Employment	4,436
Sales ($)	2,740,000,000
Value Added ($)	-
Capital Expenditure ($)	n.a.
Material Cost ($)	-
Payroll ($)	54,500,000
CONTROL COSTS	
Number of Firms (actually affected)	44
Capital ($)	4,700,000
O & M ($)	(275,000)
Annualized Capital ($)	1,020,000
Total Annualized ($)	745,000
ECONOMIC IMPACT INDICES	
Capital Control Costs as a Percentage of Annual Capital Expenditure (%)	n.a.
Total Annual Control Cost as a Percentage of Sales (%)	0.027
Total Annual Control Cost as a Percentage of Value Added (%)	-

Note: n.a. indicates that the information is unavailable. Dash indicates that the information is not applicable in this case. Parentheses enclosing dollar amounts indicate a net savings.

for all affected Ohio industries is unclear, particularly where the affected industrial category is comprised of several SIC codes. Inaccuracies in the affected industry economic statistics would have too easily been introduced had national inflation factors for SIC codes been applied.

While the effects of inflation since the 1977 economic census are not shown in the industrial cost parameters summarized in Table 10-2, it may generally be assumed that the 1981 costs are higher. Thus, in Tables 10-3 through 10-10, those economic impact indices expressed as percentages of capital expenditure or value added may be overstated.

10.3.1 Petroleum Refining

Petroleum refineries are primarily engaged in producing gasoline, kerosene, distillate and residual fuel oils, lubricants, and other products from crude petroleum. In Ohio, the refining industry is concentrated in five cities, Lima, Toledo, Canton, Findlay, and Cleveland. At present, the larger refineries remain financially sound, but the smaller facilities are closing as a result of decreasing petroleum sales. In 1977, there were ten refineries in Ohio. This number has decreased to six.[1] These refineries appear to be in no danger of closing, but only one, Ashland-Canton, has made recent capital expenditures.[2]

The industrial parameters are proportional values derived from 1977 data for ten refineries but scaled down for six refineries. These values are shown in Table 10-3. Compliance with RACT II guidelines would actually result in a net savings in operation and maintenance (O & M) costs for the refineries and, therefore, in total annualized control costs.

10.3.2 Surface Coating of Metal Parts

The types of end uses that involve surface coating of metal parts are best shown in Table 10-1. The industrial parameters that are provided in Table 10-4 were developed based on the assumption that the total industry, 8846 firms, has the potential to be affected by the new guidelines. The firms that will actually be affected will number about 87, because this is the number of firms that actually perform surface coating of metal parts. Control costs and economic indices were developed for these 87 firms alone. Economic statistics by SIC code are presented in Table 10-5.

10.3.3 Gasoline Tank Trucks

Gasoline tank trucks transport refinery products from the refineries to terminals and dispensing facilities, and from terminals to bulk plants and dispensing facilities. There are 6 refineries and 44 firms in Ohio with storage tanks and they, together with independent truck owners, operate a total of 1599 tank trucks which are likely to be affected by RACT regulations. The operation of trucks is strictly an O & M expenditure, and the control costs and economic indices presented in Table 10-6 reflect this.

10.3.4 Pharmaceutical Manufacturing

There are 41 pharmaceutical manufacturing firms in Ohio, but only two will be affected by the RACT II guidelines. Both of these firms are located in Cincinnati and are involved in the manufacture of bulk organic and inorganic medicinal chemicals and the processing of bulk botanical drugs and herbs. The ethical pharmaceutical market is growing, as reflected in the increased sales of both companies over the past few years. The impact of additional pollution control costs on these two companies is shown in Table 10-7.

10.3.5 Rubber Tire Manufacturing

Rubber tire manufacturing for cars and trucks is concentrated in the urban areas of northern Ohio. There are five rubber tire manufacturing facilities in this region, but only four will be affected by the RACT II guidelines. The facilities tend to be older because new plants are not being constructed in Ohio, and the industry is experiencing a general downturn, which results in fewer capital expenditures. The larger firms seem to be surviving the downturn, although they are losing money, but the smaller companies are closing. The cost and economic impact of complying with the new guidelines for the four firms are presented in Table 10-8.

10.3.6 Graphic Arts

The graphic arts industry provides printing services of various types to end users. The industry is growing, and should continue to grow, as the demand for this service increases. The most successful firms appear to be smaller printers who specialize and the larger printers who deal in volume orders and can afford the latest technology.

There are 277 printing firms in Ohio, but only 16 of these will actually be affected by RACT II guidelines. Compliance costs and economic impact indices for these 16 firms are presented in Table 10-9.

10.3.7 Floating Roof Tank Storage

The storage of petroleum products at bulk stations and terminals is the function of this industrial category. Gasoline sales peaked in 1978 and have been declining since that time owing to a decrease in demand. This decrease in demand is the result of high prices and has caused an increase in inventories and in the need for storage. As with other sectors of the petroleum industry, the larger firms will be able to survive while some of the smaller firms will be forced to close as a result of the industry downturn. Approximately half of the Ohio facilities are small, with less than five employees. As with the rest of the industry, few capital expenditures for new facilities are being made, although existing facilities are being modified.

Table 10-10 presents the compliance costs and economic impact for the 44 tank storage firms located in Ohio. Some of the indices could not be computed because the necessary information was not available.

10.3.8 Dry Cleaning

The number of dry-cleaning establishments that launder clothes and other items for retail, commercial, and industrial customers has been decreasing slightly. Because these businesses are service-oriented, they tend to follow the general trends of the overall economy. There are 923 dry-cleaning establishments in Ohio and industrial parameters are provided for all of these establishments in Table 10-11. Only 329

TABLE 10-11. ECONOMIC STATISTICS FOR DRY-CLEANING FACILITIES IN OHIO

INDUSTRIAL PARAMETERS	
Number of Firms (potentially affected)	923
Employment	9,741
Sales ($)	169,331,000
Value Added ($)	-
Capital Expenditure ($)	-
Material Cost ($)	-
Payroll ($)	65,994,000
CONTROL COSTS	
Number of Firms (actually affected)	329
Capital ($)	1,812,000
O & M ($)	(256,000)
Annualized Capital ($)	364,000
Total Annualized ($)	108,000
ECONOMIC IMPACT INDICES	
Capital Control Costs as a Percentage of Annual Capital Expenditure (%)	-
Total Annual Control Cost as a Percentage of Sales (%)	0.06
Total Annual Control Cost as a Percentage of Value Added (%)	-

Note: Dash indicates that the information is not applicable in this case. Parentheses enclosing dollar amounts indicate a net savings.

of these will be affected by the new guidelines, however, so the compliance cost and economic impact values presented in Table 10-11 are for the affected portion of the industry.

10.4 Discussion of Economic Impacts

The following discussion deals with the economic impact on the Ohio economy of imposing the RACT II guidelines. To assess the relative impact of additional compliance costs on Ohio industries, these costs were first calculated. They are presented in Tables 10-3 through 10-11 for each of the industrial source categories. Compliance costs vary from industry to industry depending on their projected response to the new regulations. There were three possible responses considered: (1) the addition of pollution control equipment, requiring additional capital expenditures; (2) a change in the manufacturing process, which also requires capital expenditures for equipment replacement; and (3) a change in operating procedures, which affects operating and maintenance (O & M) costs.

Once the compliance costs were calculated, they were used to calculate three economic impact indices for each of the industrial source categories. These indices are presented in Table 10-12. The first measure of economic impact considered in this study is the ratio of capital control costs, resulting from the purchase of new equipment or the replacement of existing equipment, to annual new capital expenditures. This index reflects the impact of compliance costs on each category's capital requirements. If an industry is spending a percentage of its capital budget on environmental protection, that amount may not be available for equipment replacement or plant expansion and, thus for increased production. For example, petroleum refineries would spend less than one percent of their capital budget for compliance costs, but the surface coating and graphic arts industries would have to spend 13.4 and 12.1 percent, respectively. This expenditure, which could decrease production for the surface coating and graphic arts industries, may decrease as the water-based surface coatings become more highly developed and their use more widespread. These two factors will

TABLE 10-12. COMPARISON OF ECONOMIC IMPACT INDICES FOR THE EIGHT INDUSTRIES

Index	Petroleum Refinery	Surface Coating	Gasoline Tank Trucks	Pharmaceutical Manufacture	Rubber Tire Manufacture	Graphic Arts	Floating Roof Tank Storage	Dry Cleaning
Capital Control Costs as a % of Annual Capital Expenditure	0.173	13.4	0	0.54	3.74	12.1	n.a.	-
Total Annual Control Cost as a % of Sales	(0.058)	0.123	0.006	0.007	0.042	1.19	0.027	0.06
Total Annual Control Cost as a % of Value Added	(0.44)	0.276	0.09	0.054	0.094	2.3	-	-

Note: 1) n.a. indicates that the information is not available.
2) Parentheses indicate a net savings.

tend to lower the cost of the coatings, and could result in lower pollution control expenses and more money available for product-related equipment. However, it must be recognized that capital used for pollution control does not necessarily result in decreased capital for product-related expenditures. A firm may not be forced to compromise production capital for pollution control capital, since capital availability depends upon the cost of capital as well as upon the financial and market status of both the company and the specific plant. For example, capital used to convert to a new technology (i.e., high solids or water-based inks or coatings) could simultaneously result in both pollution control and new, possibly improved, products.

The second measure of economic impact is the ratio of total annualized control costs as a percentage of the annual value of the industry's sales (or shipments). This index indicates the price impact from the annualized compliance costs. These percentages could represent potential price increases, assuming that the full cost of the additional pollution control measures was passed on (without markup) to the consumers of the affected products. The percentages represent only potential price increases, since prices depend upon numerous market factors which extend far beyond increased annualized compliance costs for pollution control. Looking at Table 10-12, the impact of the new guidelines would be greatest on the graphic arts industry. Purchasers of petroleum products would benefit from a price decrease, assuming that the net savings reflected in Table 10-12 are passed on to the consumer, and all other market conditions remained the same.

The third measure of economic impact is the ratio of total annualized control costs as a percentage of value added. This index could only be computed for industrial source categories classified by SIC codes as manufacturers. Value added is not recorded for service industries (i.e., dry cleaning). Value added is defined as the value of shipments less the total cost of materials, with an adjustment of the total for changes in inventories. The value added criteria avoids the duplication inherent in the value of sales measure due to inter-industry and intraindustry sales. It is considered the best measure for comparing the relative economic impact among industries. As before, the graphic arts industry will be affected the most, meaning that the new guidelines will cause a substantial reduction (2.3%) in the amount of earnings available after the cost of production is deducted. As indicated in Chapter 7, the sale of recovered solvent (or the anticipated cross-over in solvent and water-based ink prices) could significantly reduce the economic impact of this regulation on affected segments of the industry. The petroleum refining industry will actually experience a net savings of 0.44 percent.

Although these ratios are rough measures of the impact of the RACT II guidelines on the industrial source categories, they yield some perspective with regard to the relative economic effects of additional compliance costs. The economic significance of these costs to each category varies with its size, whether it is capital or labor intensive, the compliance costs required, and the specific market conditions under which the individual firms and plants operate.

10.5 References

1. OGJ Report, Oil and Gas Journal, Pennwell Publishing Company, Tulsa, Oklahoma, March 30, 1981.

2. Worldwide Refining and Gas Processing Directory 36th Edition, Petroleum Publishing Company, Tulsa, Oklahoma, 1978.

APPENDIX A

AFFECTED SOURCE INVENTORY

A

Table A-1

Affected Petroleum Refineries

Facility	City
Standard Oil of Ohio	Lima Toledo
Sun Company	Toledo
Ashland Petroleum	Canton Findlay
Gulf Oil Company	Cleveland

Table A-2

Affected Facilities Which Perform Surface Coating of Miscellaneous Metal Parts

SIC Code	Facility	City
254	Kiechler Manufacturing	Cincinnati
33	Erwin G. Smith	Cambridge
	Republic Steel Corp.	Youngstown
	Clow Corp Cast	Coshocton
	Benada Aluminum Product	Girard
	Alcan Aluminum Corp.	Warren
	Dura Div. Dura Corp.	Toledo
34	Williamson Company	Cincinnati
	Harvard Manufacturing	Bedford Hts.
	Youngstown Steel Door	Austintown Twp.
	Amweld Bldg. Prod.	Niles
	Lake Shore Industries	Toledo
	Louisiana Pacific	Norton
	Norandex Inc.	Walton Hills
	Goldsmith Metal Lath	Cincinnati
	Melben Products	Harrison
	Alside Inc.	Northampton Twp.
	American Building Company	Jamestown
	Leslie-Locke Building	Lodi
	Midwest Industries	Willard
	Manufacturers Enameling	Toledo
	Fisher Body GMC	Fairfield
	Republic Steel Corp.	Youngstown
	Brainard Div-Sharon Steel	Howland
	Inland Steel Container	Cleveland
	AM Multigraphics	Euclid
	Witt Company	Cincinnati
	Akron Sand Blast	Barberton
	U.S. Steel Products	Masury
	Cleveland Steel Container Corp.	Niles
	Cortland Container Corp.	Cleveland
	Queen City Barrel Company	Cincinnati
	Astro Fibre Drum	Evendale
	Mosler Safe	Hamilton
	Diebold Inc.	Hamilton
	Lunkenheimer Company	Cincinnati
	William Powell Company	Cincinnati
	Jones & Laughlin Steel	Niles
	Van Huffel Tube	Warren
	Doehler-Jarvis Casting	Toledo
	Clecon Inc.	Cleveland

Table A-2 (Continued)

SIC Code	Facility	City
	Conn Corporation	Westlake
	Diebold Inc. - Plant 1	Canton
	Matco Allied	Medina
	Wheeling - Pittsburgh	Canfield
35	Terex Div. - GMC	Brooklyn
	Euclid Inc.	Euclid
	Cincinnati Milacron	Cincinnati
	American Tool Works	Cincinnati
	Leblond Inc.	Norwood
	Queen City Barrel	Cincinnati
	Cincinnati Inc.	Harrison
	Huffman Manufacturing Company	Celina
	Lau Incorporated	Dayton
	Foster Transformer	Cincinnati
	Schulte Corporation	Cincinnati
36	Packard Electric Div.	Warren
	Alliance Manufacturing Company	Alliance
	A. O. Smith Corporation	Tipp City
	Lincoln Electric	Cleveland
	Siemans-Allis	Cincinnati
	Lincoln Electric	Cleveland
	Mansfield Products	Mansfield
	Whirlpool Corporation	Marion Twp.
	Whirlpool Corporation	Clyde
	Hoover Company - Plant 1	North Canton
	Whiteway Manufacturing	Cincinnati
	Sybron Corporation	Cincinnati
37	Ford Motor Co. - Lima Engine Plant	Lima
	Fram Corporation	Greenville
	Delco Air Conditioning	Dayton
	Delco Products	Dayton
	Dayton Walther Corporation	Dayton
	Inland Div. - Plant 1	Dayton
	Delco Products	Dayton
	Delco Air Conditioning	Moraine
	Inland Div. - Plant 3	Vandalia
	Anchor Industries Inc.	Cleveland
	Fisher Body - GMC	Cleveland
	Ford Motor - Cleveland	Brookpark
	Ford Motor	Walton Hills
	Teledyne-Monarch Rubber	Hartville
	General Electric	Evendale
	General American Transport	Masury
	MTD Products	Liverpool Twp.

Table A-2 (Continued)

SIC Code	Facility	City
384	Picker Corporation	Highland Hts.
	Cincinnati Drum Service	Reading

Table A-3

Affected Pharmaceutical Manufacturers

Facility	City
Hilton-Davis Chemical Company	Cincinnati
Merrell Dow Pharmaceuticals Inc.	Cincinnati

Table A-4

Affected Rubber Tire Manufacturers

Facility	City
B. F. Goodrich Company	Akron
Cooper Tire and Rubber Company	Findlay
Denman Rubber Manufacturing Company	Warren
General Tire Inc.	Akron

TABLE A-5

AFFECTED FLEXOGRAPHIC AND ROTOGRAVURE PRINTING ESTABLISHMENTS

Facility	City
American Can Company	Cleveland
Champion International	Olmstead Falls
Cloudsley Company	Forest Park
Colorpac Inc.	Franklin
H.S. Crocker Company	Blue Ash
Diamond International	Lockland
Diamond International	Norwood
Georgia Pacific Company	Cincinnati
Jaite Packaging Company	Akron
Ludlow Packaging Company	Mount Vernon
Mead Paper Company	Chillicothe
Ohio Match	Wadsworth
Olinkraft, Inc.	Evandale
Packaging Corporation of America	Rittman
St. Regis Paper	Middletown
Specialty Paper Company	Dayton
Zumbiel Company	Norwood

Table A-6

Facilities with Potentially Affected External Floating Roof Tanks

Facility	City
Union Oil of California	Amlin
	Oregon
	Dayton
	Cleveland
Sun Oil Company	Boardman Twp
	Oregon
	Groudview
	Dayton
	Cleveland
Sunmark Industries Div. of Sun Oil	Akron
	Toledo
Laurel Pipeline Company	Ellsworth
Texaco Inc.	Ellsworth
	Cincinnati
Standard Oil - Bulk Plant	Lima
	Shawnee Twp
	Toledo
- Toledo Refinery	Oregon
	Dayton
- Broadway Sta.	Cleveland
- Bradley Rd Term	Cleveland
	Cuyahoga Hts.
	Monroe Twp
	Tiffia
Kateenberger Tank Farm	Henry Twp
Marathon Oil Company	Oregon
	Findlay
(MP)	Oregon
	Brecksville
Shell Oil Company	Dayton
Petroleum Fuel and Terminal Company	Toledo
Ashland Petroleum	Toledo
	Cleveland
Arco Pipeline	Toledo
Global Energy	Dayton
Mobil - Cleveland Term	Cleveland
- Lebanon Term	Lebanon

Table A-6 (Continued)

Facility	City
Clark Oil & Refining Corp.	Brecksville
Defense Fuel Support Point	Cincinnati
Gulf Oil Company	Whitewater
Aurora Term & Transport	Aurora
Buckeye Pipeline Company	Mantua
Texas Eastern Trans Corp.	Middletown Clearcreek Twp
Phillips Petroleum	Aurora

APPENDIX B

RELEVANT PORTIONS OF OHIO ADMINISTRATIVE CODE
AMENDED RULES 3745-21-04, 09, AND 10

B

3745-21-04 Attainment dates and compliance time schedules.

(A) Attainment of established air quality standards for carbon monoxide and ozone, within the area, through the orderly application of pollution control techniques, shall be accomplished as expeditiously as practicable, but in no event shall such time be later than December 31, 1987.

(B) Certification and permit application requirements.

(1) EXCEPT AS OTHERWISE PROVIDED IN PARAGRAPHS (B)(2) TO (B)(4) OF THIS RULE, BY NO ~~No~~ later than December 1, 1979 ~~any-owner-or operator-of~~ FOR any air contaminant source subject to~~,-and not-specifically-exempted-from,~~ PARAGRAPHS (C) TO (S) OF rule 3745-21-09 of the Administrative Code AND BY NO LATER THAN APRIL 1, 1981 FOR ANY AIR CONTAMINANT SOURCE SUBJECT TO PARAGRAPHS (T) TO (AA) OF RULE 3745-21-09 OF THE ADMINISTRATIVE CODE, ANY OWNER OR OPERATOR OF SAID AIR CONTAMINANT SOURCE(S) shall either:

(a) Certify in writing to the director that such source is in compliance with all requirements of rule 3745-21-09 of the Administrative Code. Such certification shall include: equipment description, Ohio environmental protection agency permit application number (if assigned), and all necessary data (consistent with the appropriate permit application appendices) and calculations which confirm the compliance status. The certification shall also include an application for a permit to operate such source in accordance with rule 3745-35-02 of the Administrative Code if such source does not possess an effective permit; or

(b) Submit an application for a permit to operate or an application for a modification to a permit to operate in accordance with rule 3745-35-02 of the Administrative Code. Such application shall include a compliance program which will bring the source into compliance with all the requirements of rule 3745-21-09 of the Administrative Code as expeditiously as practicable but in no event later than the dates specified in paragraph (C) of this rule, and shall identify all reasonable interim control measures.

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(2) The certification and/or permit to operate application required by paragraph (B)(1) of this rule may include multiple facilities if such facilities are subject exclusively to paragraph (R) of rule 3745-21-09 of the Administrative Code (pertaining to gasoline dispensing facilities).

(3) THE CERTIFICATION AND/OR PERMIT TO OPERATE APPLICATION REQUIRED BY PARAGRAPH (B)(1) OF THIS RULE SHALL NOT APPLY TO ANY AIR CONTAMINANT SOURCES SUBJECT EXCLUSIVELY TO PARAGRAPH (N) OR (V) OF RULE 3745-21-09 OF THE ADMINISTRATIVE CODE (PERTAINING TO CUTBACK ASPHALTS AND GASOLINE TANK TRUCKS).

(4) THE CERTIFICATION AND/OR PERMIT TO OPERATE APPLICATION REQUIRED BY PARAGRAPH (B)(1) OF THIS RULE FOR ANY GASOLINE DISPENSING FACILITY WHICH IS SUBJECT TO PARAGRAPH (R) OF RULE 3745-21-09 OF THE ADMINISTRATIVE CODE AND WHICH HAS A MAXIMUM ANNUAL THROUGHPUT GREATER THAN ONE HUNDRED TWENTY THOUSAND GALLONS BUT LESS THAN TWO HUNDRED FORTY THOUSAND GALLONS OF GASOLINE SHALL BE FILED WITH THE DIRECTOR BY NO LATER THAN APRIL 1, 1981.

(C) Compliance time schedules.

(1) No owner or operator may cause, permit, or allow the operation or other use of any air contaminant source in violation of the limitations specified in rule 3745-21-07 of the Administrative Code or rule 3745-21-08 of the Administrative Code beyond April 15, 1977.

(2) Except as otherwise provided in paragraphs (C)(21) to (C)(26) of this rule, any owner or operator of an automobile or light-duty truck assembly plant which is subject to the requirements of paragraph (C) of rule 3745-21-09 of the Administrative Code shall achieve compliance with said requirements as expeditiously as practicable, but in no event later than the deadlines in the following schedule:

(a) Submit final control plan by July 1, 1980;

(b) Award contracts for emission control systems or process modifications; or, issue orders for the purchase of component parts to accomplish emission control or process modification by December 1, 1980;

(c) Initiate on-site construction or installation of emission control equipment or process change by March 1, 1981;

(d) Complete on-site construction or installation of emission control equipment or process change by September 1, 1982; and

(e) Achieve final compliance by December 1, 1982.

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(27) ANY OWNER OR OPERATOR OF PETROLEUM REFINERY EQUIPMENT WHICH IS SUBJECT TO THE REQUIREMENTS OF PARAGRAPH (T) OF RULE 3745-21-09 OF THE ADMINISTRATIVE CODE SHALL ACHIEVE COMPLIANCE WITH SAID REQUIREMENTS AS EXPEDITIOUSLY AS PRACTICABLE, BUT IN NO EVENT LATER THAN THE DEADLINES IN THE FOLLOWING SCHEDULE:

(a) SUBMIT TO THE DIRECTOR A MONITORING PROGRAM BY JULY 1, 1981. THIS PROGRAM SHALL CONTAIN, AT A MINIMUM, A LIST OF THE REFINERY UNITS AND THE CALENDAR QUARTER IN WHICH THEY WILL BE MONITORED, A COPY OF THE LOG BOOK FORMAT, AND THE MAKE AND MODEL OF THE MONITORING EQUIPMENT TO BE USED. IN NO CASE SHALL A CONTRACT RELIEVE THE OWNER OR OPERATOR OF A PETROLEUM REFINERY FROM THE RESPONSIBILITY FOR COMPLIANCE WITH THIS RULE.

(b) SUBMIT THE FIRST QUARTERLY MONITORING REPORT TO THE DIRECTOR BY OCTOBER 15, 1981.

(28) ANY OWNER OR OPERATOR OF A MISCELLANEOUS METAL PART OR PRODUCT COATING LINE WHICH IS SUBJECT TO THE REQUIREMENTS OF PARAGRAPH (U) OF RULE 3745-21-09 OF THE ADMINISTRATIVE CODE SHALL ACHIEVE COMPLIANCE WITH SAID REQUIREMENTS AS EXPEDITIOUSLY AS PRACTICABLE, BUT IN NO EVENT LATER THAN THE DEADLINES IN THE FOLLOWING SCHEDULE:

(a) SUBMIT FINAL CONTROL PLAN BY JULY 1, 1981;

(b) AWARD CONTRACTS FOR EMISSION CONTROL SYSTEMS OR PROCESS MODIFICATIONS; OR, ISSUE ORDERS FOR THE PURCHASE OF COMPONENT PARTS TO ACCOMPLISH EMISSION CONTROL OR PROCESS MODIFICATION BY OCTOBER 1, 1981;

(c) INITIATE ONSITE CONSTRUCTION OR INSTALLATION OF THE EMISSION CONTROL EQUIPMENT OR PROCESS CHANGE BY APRIL 1, 1982;

(d) COMPLETE ONSITE CONSTRUCTION OR INSTALLATION OF THE EMISSION CONTROL EQUIPMENT OR PROCESS CHANGE BY OCTOBER 1, 1982; AND

(e) ACHIEVE FINAL COMPLIANCE BY DECEMBER 31, 1982.

(29) ANY OWNER OR OPERATOR OF A GASOLINE TANK TRUCK WHICH IS SUBJECT TO THE REQUIREMENTS OF PARAGRAPH (V) OF RULE 3745-21-09 OF THE ADMINISTRATIVE CODE SHALL ACHIEVE COMPLIANCE WITH SAID REQUIREMENTS AS EXPEDITIOUSLY AS PRACTICABLE, BUT IN NO EVENT LATER THAN JULY 1, 1981.

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(30) ANY OWNER OR OPERATOR OF A SYNTHESIZED PHARMACEUTICAL MANUFACTURING FACILITY WHICH IS SUBJECT TO THE REQUIREMENTS OF PARAGRAPH (W) OF RULE 3745-21-09 OF THE ADMINISTRATIVE CODE SHALL ACHIEVE COMPLIANCE WITH SAID REQUIREMENTS AS EXPEDITIOUSLY AS PRACTICABLE, BUT IN NO EVENT LATER THAN THE FOLLOWING SCHEDULE:

(a) SUBMIT FINAL CONTROL PLANS BY JULY 1, 1981;

(b) AWARD CONTRACTS FOR EMISSION CONTROL SYSTEMS OR PROCESS MODIFICATIONS; OR, ISSUE ORDERS FOR THE PURCHASE OF COMPONENT PARTS TO ACCOMPLISH EMISSION CONTROL OR PROCESS MODIFICATION BY OCTOBER 1, 1981;

(c) INITIATE ONSITE CONSTRUCTION OR INSTALLATION OF THE EMISSION CONTROL EQUIPMENT OR PROCESS CHANGE BY APRIL 1, 1982;

(d) COMPLETE ONSITE CONSTRUCTION OR INSTALLATION OF THE EMISSION CONTROL EQUIPMENT OR PROCESS CHANGE BY OCTOBER 1, 1982; AND

(e) ACHIEVE FINAL COMPLIANCE BY DECEMBER 31, 1982.

(31) ANY OWNER OR OPERATOR OF A PNEUMATIC RUBBER TIRE MANUFACTURING FACILITY WHICH IS SUBJECT TO THE REQUIREMENTS OF PARAGRAPH (X) OF RULE 3745-21-09 OF THE ADMINISTRATIVE CODE SHALL ACHIEVE COMPLIANCE WITH SAID REQUIREMENTS AS EXPEDITIOUSLY AS PRACTICABLE, BUT IN NO EVENT LATER THAN THE DEADLINES IN THE FOLLOWING SCHEDULE:

(a) SUBMIT FINAL CONTROL PLANS BY JULY 1, 1981;

(b) AWARD CONTRACTS FOR EMISSION CONTROL SYSTEMS OR PROCESS MODIFICATIONS; OR, ISSUE ORDERS FOR THE PURCHASE OF COMPONENT PARTS TO ACCOMPLISH EMISSION CONTROL OR PROCESS MODIFICATION BY OCTOBER 1, 1981;

(c) INITIATE ONSITE CONSTRUCTION OR INSTALLATION OF THE EMISSION CONTROL EQUIPMENT OR PROCESS CHANGE BY APRIL 1, 1982;

(d) COMPLETE ONSITE CONSTRUCTION OR INSTALLATION OF THE EMISSION CONTROL EQUIPMENT OR PROCESS CHANGE BY OCTOBER 1, 1982; AND

(e) ACHIEVE FINAL COMPLIANCE BY DECEMBER 31, 1982.

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(32) PACKAGING ROTOGRAVURE PRINTING LINES, PUBLICATION ROTOGRAVURE PRINTING LINES, AND FLEXOGRAPHIC PRINTING LINES.

(a) EXCEPT AS PROVIDED IN PARAGRAPH (C)(32)(b) OF THIS RULE, ANY OWNER OR OPERATOR OF A PACKAGING ROTOGRAVURE PRINTING LINE, PUBLICATION ROTOGRAVURE PRINTING LINE, OR FLEXOGRAPHIC PRINTING LINE WHICH IS SUBJECT TO THE REQUIREMENTS OF PARAGRAPH (Y) OF RULE 3745-21-09 OF THE ADMINISTRATIVE CODE SHALL ACHIEVE COMPLIANCE WITH SAID REQUIREMENTS AS EXPEDITIOUSLY AS PRACTICABLE, BUT IN NO EVENT LATER THAN THE DEADLINES IN THE FOLLOWING SCHEDULE:

(i) SUBMIT FINAL CONTROL PLANS BY JULY 1, 1981;

(ii) AWARD CONTRACTS FOR EMISSION CONTROL SYSTEMS OR PROCESS MODIFICATIONS; OR, ISSUE ORDERS FOR THE PURCHASE OF COMPONENT PARTS TO ACCOMPLISH EMISSION CONTROL OR PROCESS MODIFICATION BY OCTOBER 1, 1981;

(iii) INITIATE ONSITE CONTRUCTION OR INSTALLATION OF EMISSION CONTROL EQUIPMENT OR PROCESS CHANGE BY APRIL 1, 1982;

(iv) COMPLETE ONSITE CONSTRUCTION OR INSTALLATION OF EMISSION CONTROL EQUIPMENT OR PROCESS CHANGE BY OCTOBER 1, 1982; AND

(v) ACHIEVE FINAL COMPLIANCE BY DECEMBER 31, 1982.

(b) THE DIRECTOR MAY ESTABLISH AN ALTERNATIVE COMPLIANCE SCHEDULE FOR A PRINTING LINE IDENTIFIED IN PARAGRAPH (C)(32)(a) OF THIS RULE WHICH REQUIRES SUCH PRINTING LINE TO ACHIEVE COMPLIANCE WITH PARAGRAPH (Y) OF RULE 3745-21-09 OF THE ADMINISTRATIVE CODE AS EXPEDITIOUSLY AS PRACTICABLE, BUT IN NO EVENT LATER THAN DECEMBER 31, 1987, IF THE OWNER OR OPERATOR OF THE PRINTING LINE DEMONSTRATES THE NECESSITY OF AN ALTERNATIVE SCHEDULE, TO THE SATISFACTION OF THE DIRECTOR, BY SUPPLYING THE FOLLOWING DOCUMENTATION:

(i) PROOF OF THE ECONOMIC BURDEN OF INSTALLING CONTROL EQUIPMENT WHICH WOULD ACHIEVE COMPLIANCE;

(ii) AN IDENTIFICATION OF THE SPECIFIC LOW SOLVENT CONTROL STRATEGY TO BE EMPLOYED TO ACHIEVE COMPLIANCE AND AN ENFORCEABLE SCHEDULE FOR IMPLEMENTATION OF SUCH STRATEGY;

(iii) A COMMITTMENT EARLY IN THE COMPLIANCE SCHEDULE TO PROVIDE SUBSTANTIAL REDUCTIONS OF VOLATILE ORGANIC COMPOUND EMISSIONS FROM THE PRINTING LINE;

(iv) A COMMITTMENT TO PROVIDE A GREATER REDUCTION IN VOLATILE ORGANIC COMPOUND EMISSIONS FROM THE PRINTING LINE THAN WOULD HAVE RESULTED FROM THE INSTALLATION OF CONTROL EQUIPMENT; AND

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(v) A COMMITTMENT TO INSTALL CONTROL EQUIPMENT AS A MEANS OF COMPLIANCE BY A SPECIFIED DATE (NOT LATER THAN DECEMBER 1, 1987) IF THE LOW SOLVENT CONTROL STRATEGY FAILS TO ACHIEVE COMPLIANCE BY A SPECIFIED DATE (NOT LATER THAN DECEMBER 31, 1985).

(33) ANY OWNER OR OPERATOR OR AN EXTERNAL FLOATING ROOF TANK WHICH IS SUBJECT TO THE REQUIREMENTS OF PARAGRAPH (Z) OF RULE 3745-21-09 OF THE ADMINISTRATIVE CODE SHALL ACHIEVE COMPLIANCE WITH SAID REQUIREMENTS AS EXPEDITIOUSLY AS PRACTICABLE, BUT IN NO EVENT LATER THAN THE DEADLINES IN THE FOLLOWING SCHEDULE:

(a) SUBMIT FINAL CONTROL PLAN BY JULY 1, 1981;

(b) AWARD CONTRACTS FOR EMISSION CONTROL SYSTEMS OR PROCESS MODIFICATIONS; OR, ISSUE ORDERS FOR THE PURCHASE OF COMPONENT PARTS TO ACCOMPLISH EMISSION CONTROL OR PROCESS MODIFICATION BY OCTOBER 1, 1981;

(c) INITIATE ONSITE CONSTRUCTION OR INSTALLATION OF EMISSION CONTROL EQUIPMENT OR PROCESS CHANGE BY APRIL 1, 1982;

(d) COMPLETE ONSITE CONSTRUCTION OR INSTALLATION OF EMISSION EQUIPMENT OR PROCESS CHANGE BY OCTOBER 1, 1982; AND

(e) ACHIEVE FINAL COMPLIANCE BY DECEMBER 31, 1982.

(34) ANY OWNER OR OPERATOR OF A DRY CLEANING FACILITY WHICH IS SUBJECT TO THE REQUIREMENTS OF PARAGRAPH (AA) OF RULE 3745-21-09 OF THE ADMINISTRATIVE CODE SHALL ACHIEVE COMPLIANCE WITH SAID REQUIREMENTS AS EXPEDITIOUSLY AS PRACTICABLE, BUT IN NO EVENT LATER THAN THE DEADLINES IN THE FOLLOWING SCHEDULE:

(a) SUBMIT FINAL CONTROL PLANS BY JULY 1, 1981;

(b) AWARD CONTRACTS FOR EMISSION CONTROL SYSTEMS OR PROCESS MODIFICATIONS; OR, ISSUE ORDERS FOR THE PURCHASE OF COMPONENT PARTS TO ACCOMPLISH EMISSION CONTROL OR PROCESS MODIFICATION BY OCTOBER 1, 1981;

(c) INITIATE ONSITE CONSTRUCTION OR INSTALLATION OF EMISSION CONTROL EQUIPMENT OR PROCESS CHANGE BY APRIL 1, 1982;

(d) COMPLETE ONSITE CONSTRUCTION OR INSTALLATION OF EMISSION CONTROL EQUIPMENT OR PROCESS CHANGE BY OCTOBER 1, 1982; AND

(e) ACHIEVE FINAL COMPLIANCE BY DECEMBER 31, 1982.

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3745-21-09 Control of emissions of organic compounds from stationary sources.

(A) Applicability.

(1) In Butler, Clermont, Cuyahoga, Franklin, Greene, Hamilton, Lake, Lorain, Lucas, Mahoning, Medina, Montgomery, Portage, Stark, Summit, Trumbull, Warren and Wood counties, the requirements of pargraphs (C) to (M) ~~and~~, (O) to (R), (T), (U) AND (W) TO (AA) of this rule shall apply to all existing sources of organic compounds.

(2) In those counties of the state of Ohio not specified in paragraph (A)(1) of this rule, the requirements of paragraphs (C) to (M) ~~and~~, (O) to (R), (T), (U) AND (W) TO (AA) of this rule shall apply only to existing sources of organic compounds which are located at a facility having the potential to emit a total of one hundred tons or more of organic compounds per calendar year.

(3) The requirements of ~~paragraph~~ PARAGRAPHS (N) AND (V) of this rule ~~pertaining-to-the-use-of-cutback-asphalts-in-road-paving~~ shall apply state-wide.

(B) The emission limitations specified in paragraphs (C) to (K), ~~and~~ (S), (U) AND (Y) of this rule are based upon a weighted average of all coating materials, excluding water, delivered to the coating applicator in any one day; and shall not apply to coating lines OR PRINTING LINE WHICH HAVE ~~with~~ a maximum application of coating materials less than, or equal to, three gallons in any one day.

(C) Surface coating of automobiles and light-duty trucks.

(1) No owner or operator of an automobile or light-duty truck assembly plant may cause, allow or permit the discharge into the ambient air of any volatile organic compounds after the dates specified in rule 3745-21-04 of the Administrative Code in excess of the following:

(a) For a prime coat coating line employing electrodeposition,

(i) 1.2 pounds per gallon of coating, excluding water, from the electrodeposition coating line; and

(ii) 2.9 pounds per gallon of coating, excluding water, from the guidecoat or surfacer coating line.

(b) For a prime coat coating line not employing electrodeposition, 1.9 pounds per gallon of coating, excluding water.

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(T) LEAKS FROM PETROLEUM REFINERY EQUIPMENT.

(1) EACH OWNER OR OPERATOR OF A PETROLEUM REFINERY SHALL COMPLY WITH THE FOLLOWING MONITORING, RECORD-KEEPING AND REPORTING REQUIREMENTS NO LATER THAN THE DATE SPECIFIED IN PARAGRAPH (C)(27) OF RULE 3745-21-04 OF THE ADMINISTRATIVE CODE:

(a) EXCEPT AS OTHERWISE INDICATED IN PARAGRAPH (T)(1)(b) OF THIS RULE, A MONITORING PROGRAM SHALL BE DEVELOPED AND IMPLEMENTED WHICH INCORPORATES THE FOLLOWING PROVISIONS:

(i) YEARLY MONITORING OF ALL PUMP SEALS, PIPELINE VALVES IN LIQUID SERVICE AND PROCESS DRAINS IN ACCORDANCE WITH THE METHOD SPECIFIED IN PARAGRAPH (F) OF RULE 3745-21-10 OF THE ADMINISTRATIVE CODE;

(ii) QUARTERLY MONITORING OF ALL COMPRESSOR SEALS, PIPELINE VALVES IN GAS SERVICE AND PRESSURE RELIEF VALVES IN GAS SERVICE IN ACCORDANCE WITH THE METHOD SPECIFIED IN PARAGRAPH (F) OF RULE 3745-21-10 OF THE ADMINISTRATIVE CODE;

(iii) MONTHLY MONITORING OF ALL PUMP SEALS BY VISUAL METHODS;

(iv) MONITORING OF ANY PUMP SEAL IN ACCORDANCE WITH THE METHOD SPECIFIED IN PARAGRAPH (F) OF RULE 3745-21-10 OF THE ADMINISTRATIVE CODE WITHIN FIVE WORKING DAYS AFTER ANY LIQUIDS ARE OBSERVED DRIPPING FROM THE SEAL;

(v) MONITORING OF ANY RELIEF VALVE IN ACCORDANCE WITH THE METHOD SPECIFIED IN PARAGRAPH (F) OF RULE 3745-21-10 OF THE ADMINISTRATIVE CODE WITHIN FIVE WORKING DAYS AFTER THE VALVE HAS VENTED TO THE ATMOSPHERE; AND

(vi) MONITORING OF ANY COMPONENT IN ACCORDANCE WITH THE METHOD SPECIFIED IN PARAGRAPH (F) OF RULE 3745-21-10 OF THE ADMINISTRATIVE CODE WITHIN FIVE WORKING DAYS AFTER THE REPAIR OF A LEAK;

(b) PRESSURE RELIEF DEVICES WHICH ARE CONNECTED TO AN OPERATING FLARE HEADER, VAPOR RECOVERY DEVICES, VALVES WHICH ARE NOT REASONABLY ACCESSIBLE, VALVES WHICH ARE LOCATED IN PIPELINES CONTAINING KEROSENE OR HEAVIER LIQUIDS, STORAGE TANK VALVES AND VALVES WHICH ARE NOT EXTERNALLY REGULATED ARE EXEMPT FROM THE MONITORING REQUIREMENTS CONTAINED IN PARAGRAPH (T)(1)(a) OF THIS RULE;

(c) ALL PIPELINE VALVES IN GAS SERVICE AND PRESSURE RELIEF VALVES IN GAS SERVICE SHALL BE CLEARLY MARKED AND IDENTIFIED IN SUCH A MANNER THAT THEY WILL BE OBVIOUS TO BOTH REFINERY PERSONNEL PERFORMING MONITORING AND TO THE DIRECTOR;

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(d) IF A LEAK IS IDENTIFIED AS A RESULT OF THE MONITORING PROGRAM REQUIRED BY PARAGRAPH (T)(1)(a) OF THIS RULE AND THE CONCENTRATION OF ORGANIC COMPOUNDS EXCEEDS TEN THOUSAND PARTS PER MILLION, A TAG SHALL IMMEDIATELY BE PLACED ON THE LEAKING COMPONENT. THE TAG SHALL BE READILY VISIBLE AND WEATHERPROOF; IT SHALL BEAR AN IDENTIFICATION NUMBER; AND IT SHALL CLEARLY INDICATE THE DATE THE LEAK WAS DETECTED. THE TAG SHALL REMAIN IN PLACE UNTIL THE LEAKING COMPONENT IS REPAIRED;

(e) A MONITORING LOG SHALL BE MAINTAINED FOR ALL LEAKING COMPONENTS WHICH ARE TAGGED IN ACCORDANCE WITH PARAGRAPH (T)(1)(d) OF THIS RULE. THE MONITORING LOG SHALL CONTAIN, AT A MINIMUM, THE FOLLOWING DATA:

(i) THE NAME OF THE PROCESS UNIT WHERE THE LEAKING COMPONENT IS LOCATED;

(ii) THE TYPE OF LEAKING COMPONENT (SUCH AS VALVE, SEAL, OR OTHER COMPONENT);

(iii) THE TAG NUMBER OF THE LEAKING COMPONENT;

(iv) THE DATE ON WHICH THE LEAKING COMPONENT WAS DETECTED;

(v) THE DATE ON WHICH THE LEAKING COMPONENT WAS REPAIRED;

(vi) THE DATE AND RESULTS OF THE MONITORING PERFORMED WITHIN TWENTY-FOUR HOURS AFTER THE LEAKING COMPONENT WAS REPAIRED;

(vii) A RECORD OF THE CALIBRATION OF THE MONITORING INSTRUMENT;

(viii) A LIST OF THOSE LEAKING COMPONENTS WHICH CANNOT BE REPAIRED UNTIL THE NEXT PROCESS UNIT TURNAROUND; AND

(ix) THE TOTAL NUMBER OF COMPONENTS MONITORED AND THE TOTAL NUMBER OF COMPONENTS FOUND LEAKING DURING THE CALENDAR YEAR;

(f) A COPY OF ANY MONITORING LOG SHALL BE RETAINED BY THE OWNER OR OPERATOR FOR A MINIMUM OF TWO YEARS AFTER THE DATE ON WHICH THE RECORD WAS MADE OR THE REPORT WAS PREPARED;

(g) A COPY OF ANY MONITORING LOG SHALL IMMEDIATELY BE MADE AVAILABLE TO THE DIRECTOR OR AN AUTHORIZED REPRESENTATIVE OF THE DIRECTOR, UPON VERBAL OR WRITTEN REQUEST, AT ANY REASONABLE TIME; AND

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(h) A REPORT SHALL BE SUBMITTED TO THE DIRECTOR BY THE FIFTEENTH DAY OF JANUARY, APRIL, JULY AND OCTOBER THAT GIVES THE TOTAL NUMBER OF COMPONENTS MONITORED DURING THE PREVIOUS THREE CALENDAR MONTHS, GIVES THE TOTAL NUMBER OF COMPONENTS FOUND LEAKING DURING THE PREVIOUS THREE CALENDAR MONTHS, IDENTIFIES ALL COMPONENTS WHICH WERE FOUND LEAKING DURING THE PREVIOUS THREE CALENDAR MONTHS BUT WHICH WERE NOT REPAIRED WITHIN FIFTEEN DAYS AND IDENTIFIES ALL LEAKING COMPONENTS WHICH CANNOT BE REPAIRED UNTIL THE NEXT PROCESS UNIT TURNAROUND.

(2) ANY OWNER OR OPERATOR OF A PETROLEUM REFINERY SHALL MAKE EVERY REASONABLE EFFORT TO REPAIR WITHIN FIFTEEN DAYS ANY LEAKING COMPONENT WHICH IS TAGGED AND IDENTIFIED IN ACCORDANCE WITH PARAGRAPH (T)(1)(d) OF THIS RULE, UNLESS THE LEAKING COMPONENT CANNOT BE REPAIRED UNTIL A PROCESS UNIT TURNAROUND OCCURS.

(3) THE DIRECTOR MAY REQUIRE A PROCESS UNIT TURNAROUND TO OCCUR EARLIER THAN THE NORMALLY SCHEDULED DATE IF THE NUMBER AND SEVERITY OF LEAKING COMPONENTS AWAITING A TURNAROUND WARRANT SUCH ACTION. ANY SUCH PROCESS UNIT TURNAROUND SHALL BE REQUIRED BY MEANS OF AN ORDER ISSUED BY THE DIRECTOR TO THE OWNER OR OPERATOR OF THE PETROLEUM REFINERY PURSUANT TO DIVISION (S) OF SECTION 3704.03 OF THE REVISED CODE.

(4) THE DIRECTOR MAY ACCEPT AN ALTERNATIVE MONITORING, RECORD-KEEPING AND REPORTING PROGRAM FOR THAT REQUIRED BY PARAGRAPH (T)(1) OF THIS RULE IF THE OWNER OR OPERATOR OF A PETROLEUM REFINERY CAN DEMONSTRATE TO THE SATISFACTION OF THE DIRECTOR THAT THE ALTERNATIVE PROGRAM IS AT LEAST AS EFFECTIVE IN IDENTIFYING, DOCUMENTING AND REPORTING LEAKS FROM PETROLEUM REFINERY EQUIPMENT AS THE PROGRAM OUTLINED IN PARAGRAPH (T)(1) OF THIS RULE. ANY ALTERNATIVE PROGRAM WHICH IS ACCEPTED BY THE DIRECTOR SHALL BE SPECIFIED IN THE TERMS AND CONDITIONS OF AN ORDER ISSUED BY THE DIRECTOR TO THE OWNER OR OPERATOR OF THE PETROLEUM REFINERY PURSUANT TO DIVISION (S) OF SECTION 3704.03 OF THE REVISED CODE.

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(U) SURFACE COATING OF MISCELLANEOUS METAL PARTS AND PRODUCTS.

(1) EXCEPT WHERE EXEMPTED UNDER PARAGRAPH (U)(2) OF THIS RULE, NO OWNER OR OPERATOR OF A MISCELLANEOUS METAL PART OR PRODUCT COATING LINE MAY CAUSE, ALLOW OR PERMIT THE DISCHARGE INTO THE AMBIENT AIR OF ANY VOLATILE ORGANIC COMPOUNDS FROM SUCH COATING LINE AFTER THE DATE SPECIFIED IN PARAGRAPH (C)(28) OF RULE 3745-21-04 OF THE ADMINISTRATIVE CODE UNLESS THE REQUIREMENTS OF EITHER PARAGRAPH (U)(1)(a) OR (U)(1)(b) OF THIS RULE ARE SATISFIED.

(a) THE VOLATILE ORGANIC COMPOUND CONTENT OF EACH COATING EMPLOYED IN THE MISCELLANEOUS METAL PART OR PRODUCT COATING LINE, AS DETERMINED UNDER PARAGRAPH (B) OF RULE 3745-21-10 OF THE ADMINISTRATIVE CODE, DOES NOT EXCEED THE LEAST STRINGENT OF ANY OF THE FOLLOWING LIMITATIONS WHICH ARE APPLICABLE:

(i) 4.3 POUNDS PER GALLON OF COATING, EXCLUDING WATER, FOR A CLEAR COATING;

(ii) 4.0 POUNDS PER GALLON OF COATING, EXCLUDING WATER, FOR A ZINC RICH PRIMER COATING;

(iii) 3.5 POUNDS PER GALLON OF COATING, EXCLUDING WATER, FOR AN EXTREME PERFORMANCE COATING;

(iv) 3.5 POUNDS PER GALLON OF COATING, EXCLUDING WATER, FOR ANY COATING THAT IS DRIED AT TEMPERATURES NOT EXCEEDING TWO HUNDRED DEGREES FAHRENHEIT;

(v) 5.0 POUNDS PER GALLON OF COATING, EXCLUDING WATER, FOR THE INTERIOR COATING OF A STEEL PAIL OR DRUM;

(vi) 3.5 POUNDS PER GALLON OF COATING, EXCLUDING WATER, FOR THE EXTERIOR COATING OF A STEEL PAIL OR DRUM; OR

(vii) 3.0 POUNDS PER GALLON OF COATING, EXCLUDING WATER, FOR ANY COATING THAT IS NOT REGULATED UNDER PARAGRAPHS (U)(1)(a)(i) TO (U)(1)(a)(vi) OF THIS RULE.

(b) THE MISCELLANEOUS METAL PART OR PRODUCT COATING LINE IS EQUIPPED WITH A CAPTURE SYSTEM AND ASSOCIATED CONTROL SYSTEM WHICH ARE DESIGNED AND OPERATED TO ACHIEVE THE FOLLOWING EFFICIENCIES FOR VOLATILE ORGANIC COMPOUNDS, AS DETERMINED UNDER PARAGRAPH (C) OF RULE 3745-21-10 OF THE ADMINISTRATIVE CODE:

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(i) A CAPTURE EFFICIENCY WHICH IS, IN THE JUDGMENT OF THE DIRECTOR, A MAXIMUM REASONABLE AMOUNT BASED UPON GOOD ENGINEERING DESIGN AS CONTAINED WITHIN THE FOLLOWING DOCUMENTS:

(a) "INDUSTRIAL VENTILATION", A MANUAL OF RECOMMENDED PRACTICES, FOURTEENTH EDITION, "AMERICAN FEDERATION OF INDUSTRIAL HYGIENISTS"; AND

(b) "RECOMMENDED INDUSTRIAL VENTILATION GUIDELINES", UNITED STATES DEPARTMENT OF HEALTH, EDUCATION AND WELFARE, "NATIONAL INSTITUTE OF OCCUPATIONAL SAFETY AND HEALTH"; AND

(ii) A CONTROL EFFICIENCY WHICH IS AT LEAST NINETY PER CENT BY WEIGHT.

(2) THE REQUIREMENTS OF PARAGRAPH (U)(1) OF THIS RULE SHALL NOT APPLY TO THE FOLLOWING OPERATIONS:

(a) THE APPLICATION OF AN EXTERIOR COATING TO MARINE VESSELS;

(b) THE APPLICATION OF AN EXTERIOR COATING TO AIRPLANES;

(c) THE APPLICATION OF A REFINISHING COATING TO MOTOR VEHICLES;

(d) THE APPLICATION OF A CUSTOMIZED TOPCOAT AND ANY RELATED CUSTOMIZED SINGLE COAT TO MOTOR VEHICLES, IF THE MAXIMUM NUMBER OF MOTOR VEHICLES IS LESS THAN THIRTY-FIVE PER DAY:

(e) ANY COATING LINE WHICH EMPLOYS A MAXIMUM AMOUNT OF TEN OR LESS GALLONS OF COATINGS PER DAY; AND

(f) ANY COATING LINE WHICH IS SUBJECT TO PARAGRAPH (C), (D), (E), (I), (J), (K) OR (S) OF THIS RULE.

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(V) GASOLINE TANK TRUCKS.

(1) EXCEPT WHERE EXEMPTED UNDER PARAGRAPH (V)(3) OF THIS RULE, EACH OWNER OR OPERATOR OF A GASOLINE TANK TRUCK SHALL COMPLY WITH THE FOLLOWING TESTING, RECORD-KEEPING AND REPORTING REQUIREMENTS BY THE DATE SPECIFIED IN PARAGRAPH (C)(29) OF RULE 3745-21-04 OF THE ADMINISTRATIVE CODE:

(a) NO GASOLINE TANK TRUCK IS TO BE USED FOR THE TRANSFER OF GASOLINE, UNLESS WITHIN THE PREVIOUS TWELVE MONTHS IT WAS TESTED FOR LEAKS IN ACCORDANCE WITH THE METHOD SPECIFIED IN PARAGRAPH (G) OF RULE 3745-21-10 OF THE ADMINISTRATIVE CODE;

(b) ANY GASOLINE TANK TRUCK WHICH SUSTAINS EITHER A PRESSURE DECREASE GREATER THAN 3.0 INCHES OF WATER FOR THE PRESSURE TEST OR A PRESSURE INCREASE GREATER THAN 3.0 INCHES OF WATER FOR THE VACUUM TEST WHEN LAST TESTED FOR LEAKS IN ACCORDANCE WITH THE METHOD SPECIFIED IN PARAGRAPH (G) OF RULE 3745-21-10 OF THE ADMINISTRATIVE CODE IS NOT TO BE USED FOR THE TRANSFER OF GASOLINE;

(c) A RECORD IS TO BE MAINTAINED OF ALL GASOLINE TANK TRUCKS WHICH ARE TESTED IN ACCORDANCE WITH PARAGRAPHS (V)(1)(a) AND (V)(2) OF THIS RULE, AND SUCH RECORD IS TO CONTAIN, AT A MINIMUM, THE FOLLOWING DATA:

(i) THE TANK IDENTIFICATION NUMBER OF THE GASOLINE TANK TRUCK;

(ii) THE DATE AND LOCATION OF THE TEST;

(iii) THE NAME, TITLE AND TELEPHONE NUMBER OF THE PERSON WHO CONDUCTED THE TEST, AND THE NAME AND ADDRESS OF THE COMPANY WHERE THE PERSON IS EMPLOYED;

(iv) THE TANK PRESSURE AND TIME FOR EACH OF THE FOLLOWING:

(a) THE START OF THE PRESSURE TEST;

(b) THE END OF THE PRESSURE TEST;

(c) THE START OF THE VACUUM TEST; AND

(d) THE END OF THE VACUUM TEST; AND

(v) THE RESULTANT PRESSURE CHANGES FOR THE PRESSURE TEST AND THE VACUUM TEST;

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(d) A COPY OF THE TEST RECORD REQUIRED IN PARAGRAPH (V)(1)(c) OF THIS RULE IS TO BE RETAINED BY THE OWNER OR OPERATOR OF THE TANK TRUCK FOR A MINIMUM OF TWO YEARS AFTER THE DATE ON WHICH THE TEST WAS CONDUCTED;

(e) A COPY OF THE TEST RECORD REQUIRED IN PARAGRAPH (V)(1)(c) OF THIS RULE IS TO IMMEDIATELY BE MADE AVAILABLE TO THE DIRECTOR, OR AN AUTHORIZED REPRESENTATIVE OF THE DIRECTOR, UPON VERBAL OR WRITTEN REQUEST, AT ANY REASONABLE TIME; AND

(f) A WRITTEN STATEMENT, CERTIFYING COMPLIANCE WITH THE REQUIREMENTS OF PARAGRAPHS (V)(1)(a) AND (V)(1)(b) OF THIS RULE, IS TO BE SUBMITTED BY JULY FIRST OF EACH YEAR TO EACH OWNER OR OPERATOR OF ANY BULK GASOLINE TERMINAL, BULK GASOLINE PLANT AND GASOLINE DISPENSING FACILITY AT WHICH GASOLINE IS TRANSFERRED TO OR FROM SUCH GASOLINE TANK TRUCK.

(2) THE DIRECTOR MAY REQUIRE ANY GASOLINE TANK TRUCK TO BE TESTED IN ACCORDANCE WITH THE METHOD SPECIFIED IN PARAGRAPH (G) OF RULE 3745-21-10 OF THE ADMINISTRATIVE CODE WITHIN A REASONABLE PERIOD OF TIME. ANY SUCH TEST SHALL BE REQUIRED BY MEANS OF AN ORDER ISSUED BY THE DIRECTOR TO THE OWNER OR OPERATOR OF THE GASOLINE TANK TRUCK PURSUANT TO DIVISION (S) OF SECTION 3704.03 OF THE REVISED CODE.

(3) EXEMPTED FROM THE REQUIREMENTS OF PARAGRAPHS (V)(1) AND (V)(2) OF THIS RULE IS ANY GASOLINE TANK TRUCK:

(a) WHICH DOES NOT RECEIVE GASOLINE FROM ANY LOADING RACK WHICH IS EQUIPPED WITH A VAPOR BALANCE SYSTEM OR VAPOR CONTROL SYSTEM; AND

(b) WHICH DOES NOT DELIVER GASOLINE TO ANY STATIONARY STORAGE TANK WHICH IS EQUIPPED WITH A VAPOR BALANCE SYSTEM.

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(W) SYNTHESIZED PHARMACEUTICAL MANUFACTURING FACILITY.

(1) EXCEPT WHERE EXEMPTED UNDER PARAGRAPH (W)(2) OF THIS RULE, EACH OWNER OR OPERATOR OF A SYNTHESIZED PHARMACEUTICAL MANUFACTURING FACILITY SHALL COMPLY WITH THE FOLLOWING REQUIREMENTS NO LATER THAN THE DATE SPECIFIED IN PARAGRAPH (C)(30) OF RULE 3745-21-04 OF THE ADMINISTRATIVE CODE:

(a) EXCEPT FOR ANY ORGANIC COMPOUND EMISSIONS WHICH ARE COLLECTED BY A PRODUCTION EQUIPMENT EXHAUST SYSTEM, THE DISCHARGE OF ORGANIC COMPOUND EMISSIONS INTO THE AMBIENT AIR FROM ANY REACTOR, DISTILLATION OPERATION, CRYSTALLIZER, CENTRIFUGE OR VACUUM DRYER IS TO BE CONTROLLED BY ONE OF THE FOLLOWING DEVICES:

(i) A SURFACE CONDENSER WHICH HAS AN OUTLET GAS CONCENTRATION OF ORGANIC COMPOUNDS NOT EXCEEDING FIFTY THOUSAND PARTS PER MILLION; OR

(ii) A DEVICE OR SYSTEM WHICH IS, IN THE JUDGMENT OF THE DIRECTOR, AT LEAST AS EFFECTIVE IN CONTROLLING ORGANIC COMPOUND EMISSIONS AS THE ABOVE-MENTIONED SURFACE CONDENSER;

(b) THE DISCHARGE OF ORGANIC COMPOUND EMISSIONS INTO THE AMBIENT AIR FROM ANY AIR DRYER OR PRODUCTION EQUIPMENT EXHAUST SYSTEM IS NOT TO EXCEED THIRTY-THREE POUNDS IN ANY ONE DAY, UNLESS SAID DISCHARGE HAS BEEN REDUCED BY AT LEAST NINETY PER CENT ON A WEIGHT BASIS BY CONTROL EQUIPMENT;

(c) ANY STORAGE TANK WHICH HOLDS AN ORGANIC COMPOUND LIQUID THAT HAS A VAPOR PRESSURE GREATER THAN 1.5 POUNDS PER SQUARE INCH ABSOLUTE AT SIXTY-EIGHT DEGREES FAHRENHEIT IS TO BE EQUIPPED WITH ONE OF THE FOLLOWING DEVICES:

(i) A CONSERVATION VENT WHICH OPENS AT A PRESSURE OF 0.5 OUNCE PER SQUARE INCH OR HIGHER AND AT A VACUUM OF 0.5 OUNCE PER SQUARE INCH OR HIGHER; OR

(ii) A DEVICE OR SYSTEM WHICH IS, IN THE JUDGMENT OF THE DIRECTOR, AT LEAST AS EFFECTIVE IN CONTROLLING ORGANIC COMPOUND EMISSIONS AS THE ABOVE-MENTIONED CONSERVATION VENT;

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(d) DURING ANY TRANSFER OF AN ORGANIC COMPOUND LIQUID, WHICH HAS A VAPOR PRESSURE GREATER THAN 4.1 POUNDS PER SQUARE INCH ABSOLUTE AT SIXTY-EIGHT DEGREES FAHRENHEIT, FROM A TRUCK OR RAILCAR TO A FIXED ROOF TANK WHICH HAS A CAPACITY GREATER THAN TWO THOUSAND GALLONS, THE VAPORS DISPLACED FROM SAID TANK ARE TO BE PROCESSED BY ONE OF THE FOLLOWING SYSTEMS:

(i) A VAPOR BALANCE SYSTEM WHICH IS DESIGNED AND OPERATED TO ROUTE AT LEAST NINETY PER CENT BY WEIGHT OF THE ORGANIC COMPOUNDS IN THE DISPLACED VAPORS TO THE TRUCK OR RAILCAR; OR

(ii) A VAPOR CONTROL SYSTEM WHICH IS DESIGNED AND OPERATED TO RECOVER AT LEAST NINETY PER CENT BY WEIGHT OF THE ORGANIC COMPOUNDS IN THE DISPLACED VAPORS;

(e) ANY CENTRIFUGE CONTAINING AN ORGANIC COMPOUND LIQUID, ANY ROTARY VACUUM FILTER PROCESSING AN ORGANIC COMPOUND LIQUID AND ANY OTHER FILTER HAVING AN EXPOSED ORGANIC COMPOUND LIQUID SURFACE, ARE TO BE ENCLOSED IF THE ORGANIC COMPOUND LIQUID HAS A VAPOR PRESSURE GREATER THAN 0.5 POUNDS PER SQUARE INCH ABSOLUTE AT SIXTY-EIGHT DEGREES FAHRENHEIT;

(f) ANY IN-PROCESS TANK WHICH CONTAINS AN ORGANIC COMPOUND LIQUID IS TO BE EQUIPPED WITH A COVER WHICH REMAINS CLOSED, EXCEPT WHEN PRODUCTION, SAMPLING, MAINTENANCE OR INSPECTION PROCEDURES REQUIRE ACCESS TO SAID TANK; AND

(g) ANY LEAK IN WHICH AN ORGANIC COMPOUND LIQUID IS OBSERVED TO BE RUNNING OR DRIPPING FROM A VESSEL OR OTHER EQUIPMENT IS TO BE REPAIRED AS SOON AS POSSIBLE, BUT NO LATER THAN THE FIRST TIME SAID EQUIPMENT IS OFFLINE FOR A PERIOD OF TIME LONG ENOUGH TO COMPLETE THE REPAIR.

(2) EXEMPTED FROM THE REQUIREMENTS OF PARAGRAPH (W)(1) OF THIS RULE IS ANY OPERATION OR EQUIPMENT NOT ASSOCIATED WITH THE PRODUCTION OF DRUGS.

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(X) RUBBER TIRE MANUFACTURING FACILITY.

(1) EXCEPT WHERE EXEMPTED UNDER PARAGRAPH (X)(2) OF THIS RULE, EACH OWNER OR OPERATOR OF A RUBBER TIRE MANUFACTURING FACILITY SHALL COMPLY WITH THE FOLLOWING REQUIREMENTS NO LATER THAN THE DATE SPECIFIED IN PARAGRAPH (C)(31) OF RULE 3745-21-04 OF THE ADMINISTRATIVE CODE:

(a) EACH UNDERTREAD CEMENTING, TREAD END CEMENTING AND BEAD DIPPING OPERATION IS TO BE EQUIPPED WITH A CAPTURE SYSTEM AND ASSOCIATED CONTROL SYSTEM WHICH ARE DESIGNED AND OPERATED WITH THE FOLLOWING EFFICIENCIES FOR VOLATILE ORGANIC COMPOUNDS, AS DETERMINED UNDER PARAGRAPH (C) OF RULE 3745-21-10 OF THE ADMINISTRATIVE CODE:

(i) A CAPTURE EFFICIENCY WHICH IS EITHER:

(a) AT LEAST EIGHTY-FIVE PER CENT BY WEIGHT; OR

(b) IN THE JUDGMENT OF THE DIRECTOR, A MAXIMUM REASONABLE AMOUNT BASED UPON GOOD ENGINEERING DESIGN AS CONTAINED WITHIN THE FOLLOWING DOCUMENTS:

(i) "INDUSTRIAL VENTILATION", A MANUAL OF RECOMMENDED PRACTICES, FOURTEENTH EDITION, "AMERICAN FEDERATION OF INDUSTRIAL HYGIENISTS"; AND

(ii) "RECOMMENDED INDUSTRIAL VENTILATION GUIDELINES", UNITED STATES DEPARTMENT OF HEALTH, EDUCATION AND WELFARE, "NATIONAL INSTITUTE OF OCCUPATIONAL SAFETY AND HEALTH"; AND

(ii) A CONTROL EFFICIENCY WHICH IS AT LEAST NINETY PER CENT BY WEIGHT; AND

(b) EXCEPT AS OTHERWISE PROVIDED IN PARAGRAPH (X)(1)(c) OF THIS RULE, EACH GREEN TIRE SPRAYING OPERATION IS TO BE EQUIPPED WITH A CAPTURE SYSTEM AND ASSOCIATED CONTROL SYSTEM WHICH ARE DESIGNED AND OPERATED WITH THE FOLLOWING EFFICIENCIES FOR VOLATILE ORGANIC COMPOUNDS, AS DETERMINED UNDER PARAGRAPH (C) OF RULE 3745-21-10 OF THE ADMINISTRATIVE CODE:

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(i) A CAPTURE EFFICIENCY WHICH IS EITHER:

(a) AT LEAST NINETY PER CENT BY WEIGHT; OR

(b) IN THE JUDGMENT OF THE DIRECTOR, A MAXIMUM REASONABLE AMOUNT BASED UPON GOOD ENGINEERING DESIGN AS CONTAINED WITHIN THE FOLLOWING DOCUMENTS:

(i) "INDUSTRIAL VENTILATION", A MANUAL OF RECOMMENDED PRACTICES, FOURTEENTH EDITION, "AMERICAN FEDERATION OF INDUSTRIAL HYGIENISTS"; AND

(ii) "RECOMMENDED INDUSTRIAL VENTILATION GUIDELINES", UNITED STATES DEPARTMENT OF HEALTH, EDUCATION AND WELFARE, "NATIONAL INSTITUTE OF OCCUPATIONAL SAFETY AND HEALTH"; AND

(ii) A CONTROL EFFICIENCY WHICH IS AT LEAST NINETY PER CENT BY WEIGHT;

(c) THE REQUIREMENTS OF PARAGRAPH (X)(1)(b) OF THIS RULE DO NOT APPLY TO ANY GREEN TIRE SPRAYING OPERATION IN WHICH THE VOLATILE ORGANIC COMPOUND CONTENT OF THE MATERIAL SPRAYED, AS DETERMINED BY A METHOD ACCEPTABLE TO THE DIRECTOR, IS A MAXIMUM DAILY WEIGHTED AVERAGE OF SIX PER CENT OR LESS BY WEIGHT FOR MATERIAL SPRAYED ON THE INSIDE OF A TIRE AND ELEVEN PER CENT OR LESS BY WEIGHT FOR MATERIAL SPRAYED ON THE OUTSIDE OF A TIRE.

(2) EXEMPTED FROM THE REQUIREMENTS OF PARAGRAPH (X)(1) OF THIS RULE ARE THE FOLLOWING OPERATIONS:

(a) ANY OPERATION NOT ASSOCIATED WITH RUBBER TIRES OF THE FOLLOWING SIZE:

(i) A BEAD DIAMETER LESS THAN OR EQUAL TO 20.0 INCHES; AND

(ii) A CROSS-SECTIONAL DIMENSION LESS THAN OR EQUAL TO 12.8 INCHES;

(b) ANY OPERATION IN WHICH THE MAXIMUM DISCHARGE OF VOLATILE ORGANIC COMPOUNDS INTO THE AMBIENT AIR IS ONE HUNDRED POUNDS PER DAY OR LESS; AND

(c) ANY TREAD END CEMENTING OPERATION IN WHICH THE CEMENT IS APPLIED MANUALLY WITH A BRUSH.

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(Y) FLEXOGRAPHIC, PACKAGING ROTOGRAVURE AND PUBLICATION ROTOGRAVURE PRINTING LINES.

(1) EXCEPT WHERE EXEMPTED UNDER PARAGRAPH (Y)(2) OF THIS RULE, NO OWNER OR OPERATOR OF A FLEXOGRAPHIC PRINTING LINE, PACKAGING ROTOGRAVURE PRINTING LINE OR PUBLICATION ROTOGRAVURE PRINTING LINE MAY CAUSE, ALLOW OR PERMIT THE DISCHARGE INTO THE AMBIENT AIR OF ANY VOLATILE ORGANIC COMPOUNDS FROM SUCH PRINTING LINE AFTER THE DATE SPECIFIED IN PARAGRAPH (C)(32) OF RULE 3745-21-04 OF THE ADMINISTRATIVE CODE UNLESS THE REQUIREMENTS OF EITHER PARAGRAPH (Y)(1)(a) OR (Y)(1)(b) OF THIS RULE ARE SATISFIED.

(a) THE VOLATILE ORGANIC COMPOUND CONTENT OF EACH COATING AND INK EMPLOYED IN SAID PRINTING LINE, AS DETERMINED UNDER PARAGRAPH (B) OF RULE 3745-21-10 OF THE ADMINISTRATIVE CODE, DOES NOT EXCEED THE FOLLOWING LIMITATION:

(i) FORTY PER CENT BY VOLUME, EXCLUDING WATER; OR

(ii) TWENTY-FIVE PER CENT BY VOLUME OF THE VOLATILE CONTENT.

(b) SAID PRINTING LINE IS EQUIPPED WITH A CAPTURE SYSTEM AND ASSOCIATED CONTROL SYSTEM WHICH ARE DESIGNED AND OPERATED TO ACHIEVE THE FOLLOWING EFFICIENCIES FOR VOLATILE ORGANIC COMPOUNDS, AS DETERMINED UNDER PARAGRAPH (C) OF RULE 3745-21-10 OF THE ADMINISTRATIVE CODE:

(i) A CAPTURE EFFICIENCY WHICH IS:

(a) AT LEAST SIXTY-FIVE PER CENT BY WEIGHT, FOR A FLEXOGRAPHIC PRINTING LINE;

(b) AT LEAST SEVENTY PER CENT BY WEIGHT, FOR A PACKAGING ROTOGRAVURE PRINTING LINE;

(c) AT LEAST EIGHTY PER CENT BY WEIGHT, FOR A PUBLICATION ROTOGRAVURE PRINTING LINE; OR

(d) IN THE JUDGMENT OF THE DIRECTOR, A MAXIMUM REASONABLE AMOUNT BASED UPON GOOD ENGINEERING DESIGN AS CONTAINED WITHIN THE FOLLOWING DOCUMENTS:

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(i) "INDUSTRIAL VENTILATION", A MANUAL OF RECOMMENDED PRACTICES, FOURTHEENTH EDITION, "AMERICAN FEDERATION OF INDUSTRIAL HYGIENISTS"; AND

(ii) "RECOMMENDED INDUSTRIAL VENTILATION GUIDELINES", UNITED STATES DEPARTMENT OF HEALTH, EDUCATION AND WELFARE, "NATIONAL INSTITUTE OF OCCUPATIONAL SAFETY AND HEALTH"; AND

(ii) A CONTROL EFFICIENCY WHICH IS AT LEAST NINETY PER CENT BY WEIGHT.

(2) THE REQUIREMENTS OF PARAGRAPH (Y)(1) OF THIS RULE SHALL NOT APPLY TO THE FOLLOWING PRINTING LINES:

(a) ANY PRINTING LINE WHICH APPLIES A VINYL COATING;

(b) ANY PRINTING LINE WHICH IS LOCATED AT A FACILITY IN WHICH THE TOTAL MAXIMUM DISCHARGE OF VOLATILE ORGANIC COMPOUNDS INTO THE AMBIENT AIR FROM ALL FLEXOGRAPHIC, PACKAGING ROTOGRAVURE AND PUBLICATION ROTOGRAVURE PRINTING LINES IS LESS THAN OR EQUAL TO ONE HUNDRED TONS PER YEAR; AND

(c) ANY PRINTING LINE WHICH IS USED SOLELY TO CHECK THE QUALITY OF THE IMAGE FORMATION OF NEWLY ENGRAVED OR ETCHED CYLINDERS.

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(Z) STORAGE OF PETROLEUM LIQUIDS IN EXTERNAL FLOATING ROOF TANKS.

(1) EXCEPT WHERE EXEMPTED UNDER PARAGRAPH (Z)(3) OF THIS RULE, NO OWNER OR OPERATOR OF AN EXTERNAL FLOATING ROOF TANK SHALL PLACE, STORE OR HOLD ANY PETROLEUM LIQUID IN ANY SUCH TANK AFTER THE DATE SPECIFIED IN PARAGRAPH (C)(33) OF RULE 3745-21-04 OF THE ADMINISTRATIVE CODE, UNLESS THE TANK IS DESIGNED OR EQUIPPED AS FOLLOWS:

(a) THE TANK IS EQUIPPED WITH ONE OF THE FOLLOWING:

(i) A LIQUID MOUNTED PRIMARY SEAL AND A RIM MOUNTED SECONDARY SEAL;

(ii) A MECHANICAL SHOE PRIMARY SEAL AND A RIM MOUNTED SECONDARY SEAL;

(iii) A MECHANICAL SHOE PRIMARY SEAL AND A SHOE MOUNTED SECONDARY SEAL, PROVIDED THE SHOE MOUNTED SECONDARY SEAL WAS INSTALLED PRIOR TO JANUARY 1, 1981;

(iv) A VAPOR MOUNTED PRIMARY SEAL AND A RIM MOUNTED SECONDARY SEAL, PROVIDED THE VAPOR MOUNTED PRIMARY SEAL WAS INSTALLED PRIOR TO JANUARY 1, 1981; OR

(v) A SEAL, CLOSURE OR DEVICE WHICH IS, IN THE JUDGMENT OF THE DIRECTOR, EQUIVALENT TO THE FOLLOWING DUAL SEALS IN CONTROLLING THE EMISSION OF ORGANIC COMPOUNDS INTO THE AMBIENT AIR:

(a) THE DUAL SEALS SPECIFIED IN PARAGRAPH (Z)(1)(a)(i) OR (Z)(1)(a)(ii) OF THIS RULE; OR

(b) THE DUAL SEALS SPECIFIED IN PARAGRAPH (Z)(1)(a)(iii) OR (Z)(1)(a)(iv) OF THIS RULE, PROVIDED SAID SEAL, CLOSURE OR DEVICE WAS INSTALLED PRIOR TO JANUARY 1, 1981;

(b) EACH SEAL MEETS THE FOLLOWING REQUIREMENTS:

(i) THERE ARE NO VISIBLE HOLES, TEARS, OR OTHER OPENINGS IN THE SEAL OR SEAL FABRIC;

(ii) IF THE TANK IS OF WELDED CONSTRUCTION, THE TOTAL SEAL GAP AREA, AS DETERMINED UNDER PARAGRAPH (H) OF RULE 3745-21-10 OF THE ADMINISTRATIVE CODE, DOES NOT EXCEED:

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(a) 10.0 SQUARE INCHES PER FOOT OF TANK DIAMETER FOR A LIQUID MOUNTED PRIMARY SEAL, VAPOR MOUNTED PRIMARY SEAL OR MECHANICAL SHOE PRIMARY SEAL;

(b) 1.0 SQUARE INCH PER FOOT OF TANK DIAMETER FOR A RIM MOUNTED SECONDARY SEAL OR SHOE MOUNTED SECONDARY SEAL; OR

(c) THE AMOUNT WHICH IS ASSIGNED BY THE DIRECTOR FOR ANY SEAL WHICH IS EQUIVALENT UNDER PARAGRAPH (Z)(1)(a)(v) OF THIS RULE;

(iii) IF THE TANK IS OF RIVITED CONSTRUCTION, THE MAXIMUM SEAL GAP WIDTH, AS DETERMINED UNDER PARAGRAPH (H) OF RULE 3745-21-10 OF THE ADMINISTRATIVE CODE, DOES NOT EXCEED:

(a) 2.5 INCHES FOR A MECHANICAL SHOE PRIMARY SEAL;

(b) 1.5 INCHES FOR A LIQUID MOUNTED PRIMARY SEAL, VAPOR MOUNTED PRIMARY SEAL, SHOE MOUNTED SECONDARY SEAL OR RIM MOUNTED SECONDARY SEAL; OR

(c) THE AMOUNT WHICH IS ASSIGNED BY THE DIRECTOR FOR ANY SEAL WHICH IS EQUIVALENT UNDER PARAGRAPH (Z)(1)(a)(v) OF THIS RULE;

(c) ANY OPENING IN THE EXTERNAL FLOATING ROOF, EXCEPT AUTOMATIC BLEEDER VENTS, RIM SPACE VENTS, LEG SLEEVES, STUB DRAINS AND SLOTTED GAUGING/SAMPLING WELLS, IS EQUIPPED WITH:

(i) A COVER, SEAL OR LID WHICH REMAINS IN THE CLOSED POSITION AT ALL TIMES WITHOUT ANY VISIBLE GAPS, EXCEPT WHEN THE OPENING IS IN ACTUAL USE; AND

(ii) A PROJECTION INTO THE TANK BELOW THE LIQUID SURFACE;

(d) ANY AUTOMATIC BLEEDER VENT REMAINS IN THE CLOSED POSITION, EXCEPT WHEN THE EXTERNAL FLOATING ROOF IS FLOATED OFF OR LANDED ON THE ROOF LEG SUPPORTS;

(e) ANY RIM VENT IS SET TO OPEN ONLY AT THE MANUFACTURER'S RECOMMENDED SETTING, EXCEPT WHEN THE EXTERNAL FLOATING ROOF IS BEING FLOATED OFF THE ROOF LEG SUPPORTS;

(f) ANY EMERGENCY ROOF DRAIN IS EQUIPPED WITH A SLOTTED MEMBRANE FABRIC COVER OR OTHER DEVICE WHICH COVERS AT LEAST NINETY PER CENT OF THE AREA OF THE OPENING;

(g) ANY STUB DRAIN IS EQUIPPED WITH A PROJECTION INTO THE TANK BELOW THE LIQUID SURFACE; AND

(h) ANY SLOTTED GAUGING/SAMPLING WELL IS EQUIPPED WITH AN OBJECT WHICH FLOATS ON THE LIQUID SURFACE WITHIN THE WELL AND WHICH COVERS AT LEAST NINETY PER CENT OF THE AREA OF THE WELL OPENING.

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(2) EXCEPT WHERE EXEMPTED UNDER PARAGRAPH (Z)(3) OF THIS RULE, EACH OWNER OR OPERATOR OF AN EXTERNAL FLOATING ROOF TANK WHICH CONTAINS A PETROLEUM LIQUID SHALL MEET THE FOLLOWING INSPECTION AND RECORD-KEEPING REQUIREMENTS:

(a) INSPECT ANNUALLY ANY SEAL AND SEAL FABRIC FOR COMPLIANCE WITH PARAGRAPH (Z)(1)(b)(i) OF THIS RULE;

(b) MEASURE ANNUALLY, IN ACCORDANCE WITH THE METHOD SPECIFIED IN PARAGRAPH (H) OF RULE 3745-21-10 OF THE ADMINISTRATIVE CODE, THE SECONDARY SEAL GAP OR THE PRIMARY SEAL GAP, IF THERE IS NO SECONDARY SEAL, FOR COMPLIANCE WITH THE SEAL GAP REQUIREMENTS OF PARAGRAPH (Z)(1)(b)(ii) OF THIS RULE;

(c) MEASURE AT LEAST ONCE EVERY FIVE YEARS, IN ACCORDANCE WITH THE METHOD SPECIFIED IN PARAGRAPH (H) OF RULE 3745-21-10 OF THE ADMINISTRATIVE CODE, THE PRIMARY SEAL GAP, IF THERE IS A SECONDARY SEAL, FOR COMPLIANCE WITH THE SEAL GAP REQUIREMENTS OF PARAGRAPH (Z)(1)(b)(ii);

(d) MAINTAIN FOR AT LEAST TWO YEARS A RECORD OF THE FOLLOWING:

(i) THE DATES AND RESULTS OF ANY INSPECTIONS OR MEASUREMENTS PERFORMED IN ACCORDANCE WITH PARAGRAPHS (Z)(2)(a) TO (Z)(2)(c) OF THIS RULE; AND

(ii) THE ANNUAL THROUGHPUT OF ANY PETROLEUM LIQUID STORED IN THE TANK; AND

(e) PROVIDE IMMEDIATELY TO THE DIRECTOR OR AN AUTHORIZED REPRESENTATIVE OF THE DIRECTOR, UPON WRITTEN OR VERBAL REQUEST AT ANY REASONABLE TIME, A COPY OF THE RECORD REQUIRED UNDER PARAGRAPH (Z)(2)(d) OF THIS RULE.

(3) THE FOLLOWING EXTERNAL FLOATING ROOF TANKS SHALL BE EXEMPTED FROM THE REQUIREMENTS OF PARAGRAPHS (Z)(1) AND (Z)(2) OF THIS RULE:

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(a) ANY TANK WHICH HAS A CAPACITY OF LESS THAN FORTY THOUSAND GALLONS;

(b) ANY TANK WHICH HAS A CAPACITY OF LESS THAN FOUR HUNDRED TWENTY THOUSAND GALLONS AND WHICH IS USED TO STORE PRODUCED CRUDE OIL OR CONDENSATE PRIOR TO CUSTODY TRANSFER;

(c) ANY TANK WHICH CONTAINS A PETROLEUM LIQUID WHICH, AS STORED, HAS A MAXIMUM TRUE VAPOR PRESSURE LESS THAN 1.5 POUNDS PER SQUARE INCH ABSOLUTE; AND

(d) ANY TANK WHICH CONTAINS CRUDE OIL:

  (i) WHICH HAS A POUR POINT OF FIFTY DEGREES FAHRENHEIT OR HIGHER, AS DETERMINED BY "ASTM D 97-66, TEST FOR POUR POINT OF PETROLEUM OILS"; OR

  (ii) WHICH HAS BEEN DEMONSTRATED TO THE SATISFACTION OF THE DIRECTOR TO PRODUCE A DEPOSIT THAT CAN POTENTIALLY DAMAGE ANY OTHERWISE REQUIRED SEAL.

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(AA) DRY CLEANING FACILITY.

(1) EXCEPT WHERE EXEMPTED UNDER PARAGRAPH (AA)(2), NO OWNER OR OPERATOR OF A DRY CLEANING FACILITY MAY CAUSE, ALLOW OR PERMIT THE DISCHARGE INTO THE AMBIENT AIR OF PERCHLOROETHYLENE AFTER THE DATE SPECIFIED IN PARAGRAPH (C)(34) OF RULE 3745-21-04 OF THE ADMINISTRATIVE CODE, UNLESS THE FOLLOWING REQUIREMENTS ARE MET:

(a) THE EXHAUST FROM ANY DRYER WHICH CONTAINS ARTICLES CLEANED IN PERCHLOROETHYLENE IS TO BE VENTED THROUGH ONE OF THE FOLLOWING DEVICES:

(i) A CARBON ADSORBER WHICH EMITS NO MORE THAN ONE HUNDRED PARTS PER MILLION BY VOLUME OF PERCHLOROETHYLENE AT ANY TIME; OR

(ii) A DEVICE WHICH IS, IN THE JUDGMENT OF THE DIRECTOR, AT LEAST AS EFFECTIVE IN CONTROLLING EMISSIONS OF PERCHLOROETHYLENE AS THE ABOVE-MENTIONED CARBON ADSORBER;

(b) THE WASTE FROM ANY DIATOMACEOUS EARTH FILTER WHICH HAS BEEN USED TO FILTER PERCHLOROETHYLENE IS TO CONTAIN NO MORE THAN TWENTY-FIVE PER CENT BY WEIGHT VOLATILE ORGANIC COMPOUNDS, AS DETERMINED UNDER PARAGRAPH (I) OF RULE 3745-21-10 OF THE ADMINISTRATIVE CODE;

(c) THE WASTE FROM ANY DISTILLATION OPERATION (SOLVENT STILL) WHICH HAS BEEN USED TO DISTILL PERCHLOROETHYLENE IS TO CONTAIN NO MORE THAN SIXTY PER CENT BY WEIGHT VOLATILE ORGANIC COMPOUNDS, AS DETERMINED UNDER PARAGRAPH (I) OF RULE 3745-21-10 OF THE ADMINISTRATIVE CODE;

(d) ANY DISPOSABLE FILTER CARTRIDGE WHICH HAS BEEN USED TO FILTER PERCHLOROETHYLENE IS TO BE DRAINED IN THE FILTER HOUSING FOR AT LEAST TWENTY-FOUR HOURS BEFORE BEING DISCARDED; AND

(e) ANY EQUIPMENT WHICH IS LEAKING PERCHLOROETHYLENE LIQUID IS NOT TO BE OPERATED UNTIL THE LEAK IS REPAIRED.

(2) EXEMPTIONS:

(a) PARAGRAPH (AA)(1) OF THIS RULE SHALL NOT APPLY TO ANY DRY CLEANING OPERATION WHICH IS COIN-OPERATED; AND

(b) PARAGRAPH (AA)(1)(a) OF THIS RULE (PERTAINING TO CARBON ADSORBERS) SHALL NOT APPLY TO ANY FACILITY IN WHICH THE OWNER OR OPERATOR HAS, IN THE JUDGMENT OF THE DIRECTOR, SATISFACTORILY DEMONSTRATED THAT A CARBON ADSORBER CANNOT BE INSTALLED BECAUSE OF INSUFFICIENT STEAM CAPACITY AND/OR INADEQUATE SPACE.

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3745-21-10 Compliance test methods and procedures.

(A) General provisions.

(1) The methods and procedures of this rule apply to sources governed by rule 3745-21-09 of the Administrative Code.

(2) Alternative methods and/or procedures may be used to demonstrate compliance with rule 3745-21-09 of the Administrative Code provided that such methods or procedures are in accordance with good engineering practice and authorized in writing by the director.

(3) The results of any compliance testing required by the director, other than tests conducted pursuant to paragraph (B) of this rule, shall not be accepted unless the Ohio environmental protection agency has been notified of the intent to test in accordance with paragraph (A)(4) of this rule not less than thirty days before the proposed initiation of the testing.

(4) Any person notifying the Ohio environmental protection agency of a proposed emissions compliance test shall include as part of the notification the following information:

(a) A statement indicating the purpose of the proposed test and the applicable paragraph of rule 3745-21-09 of the Administrative Code;

(b) A detailed description of the facility to be tested;

(c) A detailed description of the test procedures, equipment and sampling sites; and

(d) A timetable, setting forth the dates on which:

(i) The testing will be conducted;

(ii) The final test report will be submitted (not later than thirty days after completion of onsite sampling).

(5) For any source compliance determination, the owner or operator of the source shall be responsible for providing:

(a) Sampling ports, pipes, lines, or appurtenances for the collection of samples and data required by the test procedures;

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(b) Safe access to the sample and data collection locations; and

(c) Light, electricity, and other utilities required for sample and data collection.

(B) Method for the determination of volatile organic compound content of surface coatings.

(1) This method applies to the determination of the volatile organic compound content of paint, varnish, lacquer, and surface coatings which are air-dried or force-dried.

(2) This method does not apply to surface coatings employed in the following coating lines:

(a) Coating lines employing exposure to ultraviolet light to promote cross-linking; or

(b) Any other coating line employing a special curing process as determined by the director.

(3) For the purpose of this method, the applicable surface coatings are divided into the following three classes:

(a) Class I (general solvent type paints). This class includes white linseed oil outside paint, white soya and phthalic alkyd enamel, white linseed o-phthalic alkyd enamel, red lead primer, zinc chromate primer, flat white inside enamel, white epoxy enamel, white vinyl toluene modified alkyd, white amino modified baking enamel, and other solvent-type paints not included in class II or III.

(b) Class II (varnishes and lacquers). This class includes clear and pigmented lacquers and varnishes.

(c) Class III (waterborne paints). This class includes emulsion or latex paints and colored enamels.

(4) For the purposes of this method, a representative sample of the surface coating shall be obtained at the point of delivery to the coater or any other point in the process that is acceptable to the Ohio environmental protection agency.

(5) The volatile organic content of the sample shall be determined as follows:

(a) Assign the coating to one of the three classes in paragraph (B)(3) of this ~~section~~ RULE. Assign any coating not clearly belonging to class II or III to class I.

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(b) Determine the density D_m (in grams per cubic centimeter) of the paint, varnish, lacquer, or related product according to the procedure outlined in "ASTM D 1475-60, Standard Method of Test for Density of Paint, Varnish, Lacquer, and Related Products". Then, depending on the class of the coating, use one of the following specified procedures to determine the volatile content:

(i) Class I. Use the procedure in "ASTM D 2369-73, Standard Method of Test for Volatile Content of Paints".

(a) Record the following information:

W_1 = weight of dish and sample, grams

W_2 = weight of dish and sample after heating, grams

S = sample weight, grams

(b) Compute the volatile matter content C_v (in grams per liter of paint) as follows:

$$C_v = \frac{(W_1 - W_2)(D_m)(10^3)}{S}$$

(c) To convert grams per liter to pounds per gallon multiply C_v by 8.3455×10^{-3}.

(ii) Class II. Use the procedure in "ASTM D 1644-59 Method A, Standard Methods of Test for Nonvolatile Content of Varnishes".

(a) Record the following information:

A = weight of dish, grams

B = weight of sample used, grams

C = weight of dish and contents after heating, grams

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(b) Compute the volatile matter content C_v (in grams per liter) as follows:

$$C_v = \frac{(A + B - C)(D_m)(10^3)}{B}$$

(c) To convert grams per liter to pounds per gallon, multiply C_v by 8.3455×10^{-3}.

(iii) Class III. Use the procedure in "ASTM D 2369-73, Standard Method of Test for Volatile Content of Paints".

(a) Record the same information as specified in paragraph (B)(5)(b)(i) of this rule.

(b) Determine the water content P (in per cent water by weight) of the paint according to the procedure outlined in "Federal Standard 141A, Method 4082.1, Water in Paint and Varnishes (Karl Fischer Titration Method)".

(c) Compute the nonaqueous volatile matter content C_v (in grams per liter, EXCLUDING WATER) as follows:

$$\cancel{C_v = \frac{(W_1 - W_2 - 0.01 P S)(D_m)(10^3)}{S}}$$

$$\underline{C}_v = \frac{(\underline{W}_1 - \underline{W}_2 - 0.01\ \underline{P}\ \underline{S})(\underline{D}_m)(10^3)}{\underline{S}\ (1 - 0.01\ \underline{P})}$$

(d) To convert grams per liter, EXCLUDING WATER, to pounds per gallon, EXCLUDING WATER, multiply C_v by 8.3455×10^{-3}.

(C) Method for the determination of mass emission rate and/or control equipment efficiency for a source equipped with control equipment designed to reduce the emission of organic compounds or volatile organic compounds.

(1) The provisions of this paragraph are generally applicable to any test method employed to determine the collection or control efficiency and/or mass emission rate for any control equipment designed, installed, and operated for the purpose of reducing the emission of organic compounds or volatile organic compounds. FOR PURPOSES OF THIS PARAGRAPH "VAPOR COLLECTION SYSTEM" ALSO MEANS CAPTURE SYSTEM AND "VAPOR CONTROL SYSTEM" ALSO MEANS CONTROL SYSTEM.

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(2) The following procedures shall be included in any efficiency determination and/or mass emission rate determination where applicable:

(a) The source shall be operated at or near maximum operating capacity during any testing and the measurement of the operating rate shall be made in a manner acceptable to the Ohio environmental protection agency.

(b) The organic compound containing material shall be sampled and analyzed in a manner acceptable to the Ohio environmental protection agency such that the quantity of emissions of organic compounds or volatile organic compounds that could result from the use of the material can be quantified.

(c) The efficiency of any vapor collection system used to transport the volatile organic compound emissions from their point of origin to the vapor control equipment shall be computed or measured in a manner based upon accepted engineering practice and in a manner acceptable to the Ohio environmental protection agency.

(d) Samples of the gas stream containing organic compounds or volatile organic compounds shall be taken simultaneously at the inlet and outlet of the vapor control system in a manner acceptable to the Ohio environmental protection agency.

(e) The total combustible carbon content of the samples taken under paragraph (C)(2)(c) of this rule shall be determined by a method acceptable to the Ohio environmental protection agency.

(f) The efficiency of the vapor control system shall be expressed as the per cent of total combustible carbon content reduction achieved.

(g) The efficiency of the vapor collection system shall be expressed as the per cent of total emissions of organic compounds or volatile organic compounds emitted from the source which are vented to the vapor control system.

(h) The mass emission rate of organic compounds or volatile organic compounds shall be the sum of emissions from the vapor control system, emissions not collected by the vapor collection system and emissions from any losses associated with the vapor collection system and vapor control system.

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(F) METHOD FOR THE DETECTION OF LEAKS OF ORGANIC COMPOUNDS FROM PETROLEUM REFINERY EQUIPMENT.

(1) THIS METHOD IS APPLICABLE TO THE DETECTION OF LEAKS OF ORGANIC COMPOUNDS INTO THE AMBIENT AIR FROM PETROLEUM REFINERY EQUIPMENT.

(2) THIS METHOD DESCRIBES THE PROCEDURES TO BE FOLLOWED FOR DETECTING LEAKS OF ORGANIC COMPOUNDS FROM PETROLEUM REFINERY EQUIPMENT DURING NORMAL OPERATION BY MEANS OF A PORTABLE GAS DETECTOR. ALSO, THIS METHOD DESCRIBES THE PROCEDURES TO BE FOLLOWED FOR CALIBRATION AND PERFORMANCE TESTING OF THE PORTABLE GAS DETECTOR. (ALL MEASUREMENTS OF THE CONCENTRATION OF ORGANIC COMPOUNDS ARE EXPRESSED IN PARTS PER MILLION BY VOLUME AS HEXANE.)

(3) ANY PORTABLE GAS DETECTOR SHALL:

(a) BE EQUIPPED WITH A PUMP FOR CONTINUOUS SAMPLING;

(b) HAVE THE CAPABILITY (OR OPTION) FOR MEASURING CONCENTRATIONS IN THE RANGE OF TEN THOUSAND PARTS PER MILLION BY VOLUME;

(c) BE EQUIPPED WITH A METER OR OTHER READOUT DEVICE WHICH CAN BE READ TO PLUS OR MINUS FIVE PER CENT AT TEN THOUSAND PARTS PER MILLION BY VOLUME; AND

(d) MEET THE FOLLOWING PERFORMANCE CRITERIA:

(i) THE ZERO DRIFT FOR A TWO-HOUR PERIOD DOES NOT EXCEED FIVE PARTS PER MILLION BY VOLUME AS HEXANE;

(ii) THE CALIBRATION DRIFT FOR A TWO-HOUR PERIOD DOES NOT EXCEED FIVE PER CENT OF THE CONCENTRATION OF THE CALIBRATION GAS;

(iii) THE CALIBRATION ERROR DOES NOT EXCEED FIVE PER CENT OF THE CONCENTRATION OF THE CALIBRATION GAS; AND

(iv) THE RESPONSE TIME DOES NOT EXCEED FIVE SECONDS.

(4) THE FOLLOWING GAS MIXTURES SHALL BE EMPLOYED FOR THE CALIBRATION AND PERFORMANCE TESTING OF THE PORTABLE GAS DETECTOR, EXCEPT AS PROVIDED IN PARAGRAPH (F)(5) OF THIS RULE:

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(a) A ZERO GAS WHICH CONTAINS LESS THAN THREE PARTS PER MILLION BY VOLUME OF HEXANE IN AIR; AND

(b) A CALIBRATION GAS WHICH CONTAINS ABOUT TEN THOUSAND PARTS PER MILLION BY VOLUME OF HEXANE IN AIR ACCURATE TO WITHIN PLUS OR MINUS TWO PER CENT.

(5) AN ALTERNATIVE GAS MAY BE USED IN PLACE OF HEXANE IN PARAGRAPH (F)(4) OF THIS RULE PROVIDED A RELATIVE RESPONSE FACTOR FOR THE PORTABLE GAS DETECTOR IS DETERMINED SO THAT CALIBRATIONS WITH THE ALTERNATIVE GAS MAY BE EXPRESSED AS HEXANE EQUIVALENTS ON THE METER OR READOUT DEVICE.

(6) ANY PORTABLE GAS DETECTOR WHICH IS USED UNDER THIS METHOD SHALL BE SUBJECT TO AND MUST PASS THE PERFORMANCE TEST SPECIFIED IN PARAGRAPH (F)(7) OF THIS RULE AT THE FOLLOWING TIMES:

(a) PRIOR TO BEING PLACED INTO INITIAL SERVICE;

(b) PRIOR TO BEING PLACED INTO SERVICE AFTER ANY REPAIR OR MODIFICATION; AND

(c) WITHIN SIX MONTHS AFTER THE MOST RECENT PERFORMANCE TEST.

(7) A PERFORMANCE TEST OF A PORTABLE GAS DETECTOR SHALL BE CONDUCTED ACCORDING TO THE FOLLOWING PROCEDURES:

(a) ASSEMBLE AND START UP THE PORTABLE GAS DETECTOR IN ACCORDANCE WITH THE MANUFACTURER'S INSTRUCTIONS FOR RECOMMENDED WARMUP AND PRELIMINARY ADJUSTMENT;

(b) TEST THE ZERO DRIFT AND CALIBRATION DRIFT AS FOLLOWS:

(i) CALIBRATE THE PORTABLE GAS DETECTOR ACCORDING TO THE MANUFACTURER'S INSTRUCTIONS WITH THE ZERO AND CALIBRATION GASES SPECIFIED IN PARAGRAPH (F)(4) OF THIS RULE AND RECORD THE TIME, THE INITIAL ZERO GAS READING AND THE INITIAL CALIBRATION GAS READING;

(ii) AFTER TWO HOURS OF CONTINUOUS OPERATION, INTRODUCE THE ZERO AND CALIBRATION GASES INTO THE PORTABLE GAS DETECTOR AND RECORD THE FINAL ZERO GAS READING AND THE FINAL CALIBRATION GAS READING;

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(iii) REPEAT FOR THREE MORE RUNS THE PROCEDURES IN PARAGRAPHS (F)(7)(b)(i) AND (F)(7)(b)(ii) OF THIS RULE;

(iv) CALCULATE THE MEAN ZERO DRIFT BY ADDING THE ABSOLUTE VALUES OF THE DIFFERENCES BETWEEN THE INITIAL AND FINAL ZERO GAS READINGS FOR THE FOUR TWO-HOUR RUNS AND DIVIDING BY FOUR;

(v) CALCULATE THE MEAN CALIBRATION DRIFT BY ADDING THE ABSOLUTE VALUES OF THE DIFFERENCES BETWEEN THE INITIAL AND FINAL CALIBRATION GAS READINGS FOR THE FOUR TWO-HOUR RUNS AND DIVIDING BY FOUR; AND

(vi) IF THE MEAN ZERO DRIFT EXCEEDS FIVE PARTS PER MILLION BY VOLUME AS HEXANE OR IF THE MEAN CALIBRATION DRIFT EXCEEDS FIVE PER CENT OF THE CONCENTRATION OF THE CALIBRATION GAS, THE PORTABLE GAS DETECTOR HAS FAILED THE PERFORMANCE TEST;

(c) TEST THE CALIBRATION ERROR AS FOLLOWS:

(i) CALIBRATE THE PORTABLE GAS DETECTOR ACCORDING TO THE MANUFACTURER'S INSTRUCTIONS WITH THE ZERO AND CALIBRATION GASES SPECIFIED IN PARAGRAPH (F)(4) OF THIS RULE;

(ii) OBTAIN AND RECORD NINE MEASUREMENTS OF THE CONCENTRATION OF THE CALIBRATION GAS BY ALTERNATING BETWEEN THE ZERO GAS AND THE CALIBRATION GAS;

(iii) CALCULATE THE MEAN CALIBRATION ERROR BY ADDING THE ABSOLUTE VALUES OF THE DIFFERENCES BETWEEN THE CALIBRATION GAS CONCENTRATIONS AND THE RECORDED MEASUREMENTS FOR THE NINE MEASUREMENTS AND DIVIDING BY NINE; AND

(iv) IF THE MEAN CALIBRATION ERROR EXCEEDS FIVE PER CENT OF THE CONCENTRATION OF THE CALIBRATION GAS, THE PORTABLE GAS DETECTOR HAS FAILED THE PERFORMANCE TEST;

(d) TEST THE RESPONSE TIME AS FOLLOWS:

(i) CALIBRATE THE PORTABLE GAS DETECTOR ACCORDING TO THE MANUFACTURER'S INSTRUCTIONS WITH THE ZERO AND CALIBRATION GASES SPECIFIED IN PARAGRAPH (F)(4) OF THIS RULE;

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(ii) INTRODUCE ZERO GAS INTO THE PORTABLE GAS DETECTOR THROUGH THE DETECTOR'S PROBE; WAIT FOR THE METER OR READOUT DEVICE TO STABILIZE; SWITCH QUICKLY TO THE CALIBRATION GAS; MEASURE THE TIME THE METER OR READOUT DEVICE TAKES TO REACH NINETY-FIVE PER CENT OF THE CALIBRATION READING AFTER THE SWITCH TO THE CALIBRATION GAS (RESPONSE TIME); AND RECORD THE RESPONSE TIME;

(iii) PERFORM THE TEST SEQUENCE IN PARAGRAPH (F)(7)(d)(ii) OF THIS RULE THREE TIMES;

(iv) CALCULATE THE MEAN RESPONSE TIME BY ADDING THE THREE RESPONSE TIMES AND DIVIDING BY THREE; AND

(v) IF THE MEAN RESPONSE TIME EXCEEDS FIVE SECONDS, THE PORTABLE GAS DETECTOR HAS FAILED THE PERFORMANCE TEST.

(8) PETROLEUM REFINERY EQUIPMENT SHALL BE TESTED FOR LEAKS ACCORDING TO THE FOLLOWING PROCEDURES:

(a) CALIBRATE THE PORTABLE GAS DETECTOR ACCORDING TO THE MANUFACTURER'S INSTRUCTIONS WITH THE ZERO AND CALIBRATION GASES SPECIFIED IN PARAGRAPH (F)(4) OF THIS RULE;

(b) OBTAIN A GAS SAMPLE FROM THE COMPONENT BY PLACING THE PROBE AT AN INTERFACE OR EMISSION POINT IN THE FOLLOWING MANNER:

(i) FOR BLOCK (GLOVE, PLUG, GATE, BALL, ETC.) AND CONTROL VALVES, THE PROBE SHOULD BE PLACED AT THE INTERFACE WHERE THE STEM EXITS THE SEAL, AND SAMPLES SHOULD BE TAKEN ON ALL SIDES OF THE STEM;

(ii) FOR VALVES IN WHICH THE HOUSING IS A MULTIPART ASSEMBLY OR IN WHICH LEAKS CAN OCCUR FROM POINTS OTHER THAN THE STEM SEAL, THE PROBE SHOULD BE PLACED AT THE INTERFACE OF THE HOUSING OR OTHER POSSIBLE LEAKING POINT;

(iii) FOR WELDED FLANGES, THE PROBE SHOULD BE PLACED AT THE INTERFACE BETWEEN THE FLANGE AND GASKET, AND SAMPLES SHOULD BE TAKEN FROM AROUND THE CIRCUMFERENCE OF THE FLANGE;

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(iv) FOR CONNECTIONS WHICH ARE NOT FLANGES (E.G., THREADED CONNECTIONS), THE PROBE SHOULD BE PLACED AT THE INTERFACE OF THE CONNECTION AND SAMPLES SHOULD BE TAKEN FROM AROUND THE CIRCUMFERENCE OF THE CONNECTION;

(v) FOR PUMPS AND COMPRESSORS, THE PROBE SHOULD BE PLACED AT ALL ACCESSIBLE PORTIONS OF THE INTERFACE BETWEEN THE HOUSING SEAL AND THE OUTER SURFACE OF THE PUMP OR COMPRESSOR, WITHIN 0.5 INCHES OF ANY SHAFT-SEAL INTERFACE IN WHICH THE PROBE CANNOT BE PLACED IN CONTACT WITH A ROTATING SHAFT, AT ALL OTHER JOINTS WHERE LEAKAGE COULD OCCUR, AND, IF SEALING OIL IS USED, AT APPROXIMATELY THE CENTER OF THE END OF THE VENT FROM THE SEAL OIL RESERVOIR;

(vi) FOR PRESSURE RELIEF VALVES WHICH HAVE AN ENCLOSED EXTENSION OR HORN, THE PROBE SHOULD BE PLACED AT APPROXIMATELY THE CENTER OF THE EXHAUST AREA TO THE AMBIENT AIR;

(vii) FOR OPEN PROCESS DRAINS, THE PROBE SHOULD BE PLACED AT APPROXIMATELY THE CENTER OF THE AREA OPEN TO THE AMBIENT AIR;

(viii) FOR COVERED PROCESS DRAINS, THE PROBE SHOULD BE PLACED AT THE COVER'S CIRCUMFERENTIAL INTERFACE; AND

(ix) FOR OPEN-ENDED VALVES (E.G., SAMPLE TAPS OR DRAIN LINES), THE PROBE SHOULD BE PLACED AT APPROXIMATELY THE CENTER OF THE UNCAPPED OPENING TO THE AMBIENT AIR;

(c) WHEN SAMPLING AN INTERFACE ON A COMPONENT, MOVE THE PROBE SLOWLY ALONG THE SURFACE OF THE INTERFACE WITH THE INLET OF THE PROBE POSITIONED AT THE LOCAL UPWIND AND DOWNWIND SIDE OF THE INTERFACE; AND

(d) FOR ANY SAMPLE WHICH HAS A CONCENTRATION EXCEEDING TEN THOUSAND PARTS PER MILLION BY VOLUME AS HEXANE, RECORD THE DATE, TIME AND COMPONENT'S IDENTIFICATION.

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(9) AN ALTERNATIVE METHOD OF LEAK DETECTION, BASED UPON THE MEASUREMENT OF AMBIENT ORGANIC COMPOUND CONCENTRATIONS IN A PROCESS UNIT AREA, MAY BE USED IN PLACE OF THE TESTING OF EACH COMPONENT BY THE METHOD SPECIFIED IN PARAGRAPHS (F)(1) TO (F)(8) OF THIS RULE IF, IN THE JUDGMENT OF THE DIRECTOR, SUCH ALTERNATIVE METHOD IS EFFECTIVE IN LOCATING INDIVIDUAL EQUIPMENT LEAKS. ANY EQUIPMENT WHICH IS LOCATED WITHIN A PROCESS UNIT AREA AND WHICH IS DETERMINED TO HAVE AN EXCESSIVE LEAK BY SUCH ALTERNATIVE METHOD SHALL ALSO BE TESTED BY THE PROCEDURES CONTAINED IN PARAGRAPHS (F)(1) TO (F)(8) OF THIS RULE.

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(G) METHOD FOR THE DETERMINATION OF THE LEAK TIGHTNESS OF GASOLINE TANK TRUCKS.

(1) THIS METHOD IS APPLICABLE TO DETERMINING THE LEAK TIGHTNESS OF GASOLINE TANK TRUCKS WHICH ARE EQUIPPED WITH PIPING, HOSES AND OTHER DEVICES FOR THE COLLECTION OR RETURN OF GASOLINE VAPORS DURING THE TRANSFER OF GASOLINE AT A GASOLINE DISPENSING FACILITY, BULK GASOLINE PLANT OR BULK GASOLINE TERMINAL.

(2) THIS METHOD DESCRIBES THE TEST CONDITIONS AND TEST PROCEDURES TO BE FOLLOWED IN DETERMINING THE LEAK TIGHTNESS OF GASOLINE TANK TRUCKS. UNDER THESE PROCEDURES THE CHANGE OF PRESSURE WITHIN THE COMPARTMENTS OF A GASOLINE TANK TRUCK ARE RECORDED AT A SPECIFIED TIME AFTER THE COMPARTMENTS ARE PRESSURIZED TO A SPECIFIED PRESSURE AND AFTER THE COMPARTMENTS ARE EVACUATED TO A SPECIFIED PRESSURE.

(3) THE FOLLOWING EQUIPMENT ARE REQUIRED FOR THIS METHOD:

(a) A PUMP, BLOWER OR CYLINDER OF COMPRESSED AIR OR INERT GAS WHICH IS CAPABLE OF PRESSURIZING THE GASOLINE TANK TRUCK TO TWENTY-FIVE INCHES OF WATER ABOVE ATMOSPHERIC PRESSURE;

(b) A LOW PRESSURE REGULATOR WHICH IS USED TO CONTROL THE PRESSURIZATION OF THE GASOLINE TANK TRUCK;

(c) A VACUUM PUMP WHICH IS CAPABLE OF EVACUATING THE GASOLINE TANK TRUCK TO TEN INCHES OF WATER BELOW ATMOSPHERIC PRESSURE;

(d) A LIQUID MANOMETER (OR EQUIVALENT INSTRUMENT) WHICH IS CAPABLE OF MEASURING UP TO TWENTY-FIVE INCHES OF WATER GAUGE PRESSURE WITH A PRECISION OF PLUS OR MINUS 0.1 INCHES OF WATER;

(e) A TEST CAP WHICH HAS A FITTING FOR CONNECTION TO THE GASOLINE TANK TRUCK'S VAPOR RECOVERY LINE, A PRESSURE TAP FOR CONNECTION TO THE MANOMETER (OR EQUIVALENT INSTRUMENT), AND A SHUT-OFF VALVE FOR CONNECTION TO THE PRESSURE/VACUUM SUPPLY LINE;

(f) AN IN-LINE PRESSURE/VACUUM RELIEF VALVE WHICH IS SET TO ACTIVATE AT TWENTY-EIGHT INCHES OF WATER ABOVE ATMOSPHERIC PRESSURE OR TWELVE INCHES OF WATER BELOW ATMOSPHERIC PRESSURE AND WHICH HAS A CAPACITY EQUAL TO THE CAPACITY OF THE PRESSURE AND EVACUATION EQUIPMENT;

(g) CAPS FOR THE LIQUID DELIVERY LINES; AND

(h) A PRESSURE/VACUUM SUPPLY LINE.

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(4) THE PRE-TEST CONDITIONS ARE AS FOLLOWS:

(a) THE GASOLINE TANK TRUCK SHALL BE PURGED OF GASOLINE VAPORS IN A SAFE MANNER (E.G., FLUSHING WITH DIESEL FUEL OR HEATING FUEL) AND SHALL BE TESTED EMPTY; AND

(b) THE GASOLINE TANK TRUCK SHALL BE LOCATED AT A SITE WHICH IS PROTECTED FROM DIRECT SUNLIGHT.

(5) THE TEST PROCEDURES ARE AS FOLLOWS:

(a) OPEN AND CLOSE THE DOME COVERS;

(b) CONNECT STATIC ELECTRICAL GROUND CONNECTIONS TO THE GASOLINE TANK TRUCK, ATTACH THE DELIVERY AND VAPOR HOSES, REMOVE THE DELIVERY ELBOWS AND ATTACH CAPS TO THE LIQUID DELIVERY LINES;

(c) CONNECT THE TEST CAP TO THE VAPOR RECOVERY LINE OF THE GASOLINE TANK TRUCK, CONNECT THE PRESSURE/VACUUM SUPPLY LINE AND THE PRESSURE/VACUUM RELIEF VALVE TO THE SHUT-OFF VALVE IN THE TEST CAP, CONNECT THE MANOMETER (OR EQUIVALENT INSTRUMENT) TO THE PRESSURE TAP IN THE TEST CAP;

(d) CONNECT THE COMPARTMENTS OF THE GASOLINE TANK TRUCK INTERNALLY TO EACH OTHER, IF POSSIBLE (IF NOT POSSIBLE, EACH COMPARTMENT MUST BE TESTED SEPARATELY);

(e) CONNECT THE PRESSURE SOURCE TO THE PRESSURE/VACUUM SUPPLY LINE;

(f) OPEN THE SHUT-OFF VALVE IN THE TEST CAP AND ALLOW THE PRESSURE WITHIN THE GASOLINE TANK TRUCK (OR, ALTERNATIVELY, A COMPARTMENT OF THE GASOLINE TANK TRUCK) TO SLOWLY REACH THIRTEEN INCHES OF WATER GAUGE PRESSURE;

(g) CLOSE THE SHUT-OFF VALVE IN THE TEST CAP, ALLOW THE PRESSURE TO STABILIZE, AND ADJUST THE PRESSURE, IF NECESSARY, TO MAINTAIN THIRTEEN INCHES OF WATER;

(h) RECORD THE TIME AND INITIAL PRESSURE WHEN THE PRESSURE IS STABLE AT NO LESS THAN 18.0 INCHES OF WATER GAUGE PRESSURE, WITH THE SHUT-OFF VALVE IN THE TEST CAP CLOSED;

(i) RECORD THE TIME AND FINAL PRESSURE AT THE END OF FIVE MINUTES AFTER THE INITIAL PRESSURE READING;

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(j) DISCONNECT THE PRESSURE SOURCE FROM THE PRESSURE/VACUUM LINE AND OPEN SLOWLY THE SHUT-OFF VALVE IN THE TEST CAP TO ALLOW THE PRESSURE IN THE GASOLINE TANK TRUCK (OR, ALTERNATIVELY, A COMPARTMENT OF THE GASOLINE TANK TRUCK) TO REACH ATMOSPHERIC PRESSURE;

(k) CONNECT THE VACUUM SOURCE TO THE PRESSURE/VACUUM SUPPLY LINE;

(l) OPEN THE SHUT-OFF VALVE IN THE TEST CAP AND ALLOW THE PRESSURE WITHIN THE GASOLINE TANK TRUCK (OR, ALTERNATIVELY, A COMPARTMENT OF THE GASOLINE TANK TRUCK) TO SLOWLY REACH MINUS SIX INCHES OF WATER GAUGE PRESSURE;

(m) CLOSE THE SHUT-OFF VALVE IN THE TEST CAP, ALLOW THE PRESSURE TO STABILIZE AND ADJUST THE PRESSURE, IF NECESSARY, TO MAINTAIN MINUS SIX INCHES OF WATER GAUGE PRESSURE;

(n) RECORD THE TIME AND INITIAL PRESSURE WHEN THE PRESSURE IS STABLE AT NO MORE THAN MINUS SIX INCHES OF WATER GAUGE PRESSURE, WITH THE SHUT-OFF VALVE IN THE TEST CAP CLOSED;

(o) RECORD THE TIME AND FINAL PRESSURE AT THE END OF FIVE MINUTES AFTER THE INITIAL PRESSURE READING;

(p) DISCONNECT THE VACUUM SOURCE FROM THE PRESSURE/VACUUM LINE AND SLOWLY OPEN THE SHUT-OFF VALVE IN THE TEST CAP TO ALLOW THE PRESSURE IN THE GASOLINE TANK TRUCK (OR, ALTERNATIVELY, A COMPARTMENT OF THE GASOLINE TANK TRUCK) TO REACH ATMOSPHERIC PRESSURE; AND

(q) REPEAT THE TEST PROCEDURES CONTAINED IN PARAGRAPHS (G)(5)(e) TO (G)(5)(p) OF THIS RULE FOR EACH COMPARTMENT OF THE GASOLINE TANK TRUCK IF THE COMPARTMENTS COULD NOT BE INTERCONNECTED AS SPECIFIED IN PARAGRAPH (G)(5)(d) OF THIS RULE.

(6) AN ALTERNATIVE METHOD MAY BE USED FOR TESTING THE LEAK TIGHTNESS OF THE GASOLINE TANK TRUCK PROVIDED SUCH ALTERNATIVE METHOD HAS BEEN DEMONSTRATED TO THE SATISFACTION OF THE DIRECTOR AS EQUIVALENT TO THIS METHOD AND HAS BEEN APPROVED BY THE DIRECTOR IN WRITING.

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(H) METHOD FOR THE DETERMINATION OF SEAL GAPS IN AN EXTERNAL FLOATING ROOF TANK.

(1) THIS METHOD IS APPLICABLE TO DETERMINING THE WIDTH AND AREA OF ANY GAPS BETWEEN THE WALL OF AN EXTERNAL FLOATING ROOF TANK AND A SEAL WHICH IS AROUND THE CIRCUMFERENCE OF THE EXTERNAL FLOATING ROOF.

(2) THE WIDTH OF ANY SEAL GAP IS THE DISTANCE BETWEEN THE SEAL AND THE TANK WALL. IT IS DETERMINED BY USING PROBES OF VARIOUS WIDTHS TO ACCURATELY MEASURE THE ACTUAL DISTANCE FROM THE SEAL TO THE TANK WALL.

(3) THE AREA OF ANY SEAL GAP IS DETERMINED BY MULTIPLYING THE WIDTH OF THE SEAL GAP, AS DETERMINED IN PARAGRAPH (H)(2) OF THIS RULE, BY THE CIRCUMFERENTIAL LENGTH OF THE GAP.

(4) THE TOTAL SEAL GAP AREA IS THE ACCUMULATED AREA OF ALL GAPS WHICH ARE GREATER THAN 0.125 INCHES IN WIDTH.

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(I) METHOD FOR THE DETERMINATION OF THE VOLATILE ORGANIC CONTENT OF WASTES AT A DRY CLEANING FACILITY WHICH USES PERCHLOROETHYLENE.

(1) THE METHOD IS APPLICABLE TO DETERMINING THE VOLATILE ORGANIC COMPOUND CONTENT IN PER CENT BY WEIGHT FOR WASTE AT A DRY CLEANING FACILITY FROM ANY DISTILLATION OPERATION WHICH DISTILLS PERCHLOROETHYLENE AND FROM ANY DIATOMACEOUS EARTH FILTER WHICH FILTERS PERCHLOROETHYLENE.

(2) THE VOLATILE ORGANIC COMPOUND CONTENT OF THE WASTE IN PER CENT BY VOLUME IS DETERMINED IN ACCORDANCE WITH THE PROCEDURE IN "ASTM D 33-67, STANDARD TEST METHOD FOR GASOLINE DILUENT IN USED GASOLINE ENGINE OILS BY DISTILLATION" AND IS CALCULATED AS THE DILUENT CONTENT IN THAT PROCEDURE.

(3) THE DENSITY OF THE WASTE IS DETERMINED BY WEIGHING A KNOWN VOLUME OF THE WASTE AND IS CALCULATED AS THE NET WEIGHT OF THE WASTE IN POUNDS DIVIDED BY THE VOLUME OF THE WASTE IN GALLONS.

(4) THE VOLATILE ORGANIC COMPOUND CONTENT OF THE WASTE IN PER CENT BY WEIGHT IS CALCULATED AS THE PRODUCT OF ITS DILUENT CONTENT AND 13.55, DIVIDED BY ITS DENSITY.

Effective: March 27, 1981

Certification: James F McAvoy

Date

Promulgated under: RC Chapter 119
Rule amplifies: RC Chapter 3704
Amended: 10/19/79

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